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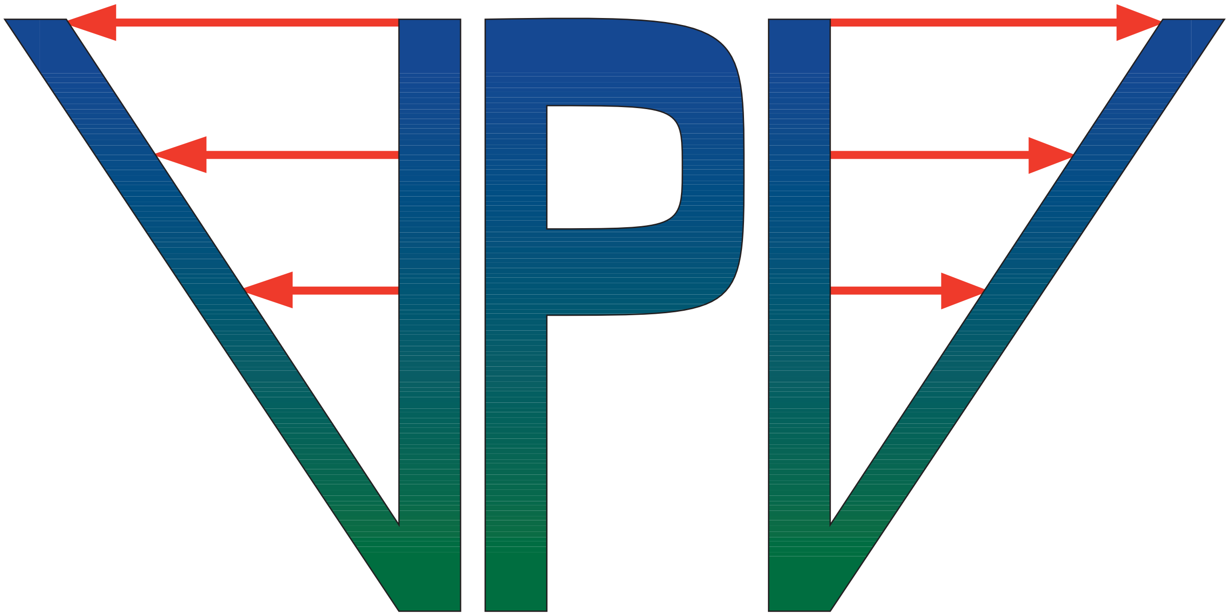
VPV—The Velocity Profile Viewer User Manual



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By John M. Donovan

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Conversion Factors and Acronyms

Multiply	By	To obtain
centimeter per second (cm/s)	0.0328084	foot per second

Acronyms

3D	three-dimensional
ADVM	acoustic Doppler velocity meter
DLL	Dynamic Link Library
GLUT	Graphics Library Utility Toolkit
IRIS GL	IRIS Graphics Library
MFC	Microsoft Foundation Classes
OpenGL	Open Graphics Library
PC	personal computer
SGI	Silicon Graphics, Inc.
USGS	U.S. Geological Survey
VPV	Velocity Profile Viewer

VPV—The Velocity Profile Viewer User Manual

by John M. Donovan

Abstract

The Velocity Profile Viewer (VPV) is a tool for visualizing time series of velocity profiles developed by the U.S. Geological Survey (USGS). The USGS uses VPV to preview and present measured velocity data from acoustic Doppler current profilers and simulated velocity data from three-dimensional estuarine, river, and lake hydrodynamic models. The data can be viewed as an animated three-dimensional profile or as a stack of time-series graphs that each represents a location in the water column.

The graphically displayed data are shown at each time step like frames of animation. The animation can play at several different speeds or can be suspended on one frame. The viewing angle and time can be manipulated using mouse interaction. A number of options control the appearance of the profile and the graphs. VPV cannot edit or save data, but it can create a PostScript file showing the velocity profile in three dimensions. This user manual describes how to use each of these features. VPV is available to be downloaded for free from the World Wide Web at *http://ca.water.usgs.gov/program/sfbay/vpv*.

Introduction

The Velocity Profile Viewer (VPV) is a software application developed by the U.S. Geological Survey (USGS) for visualizing scientific data, specifically velocity profiles. It originally was created in response to evolving data-collection and three-dimensional (3D) modeling technology that had outpaced older visualization methods. Primarily, it was designed to meet the needs of a group of research scientists studying the San Francisco Bay and Delta, but it has evolved into a tool that other scientists can use to study environmental flows.

This report provides a formal and complete description and user manual for VPV. The history of development is given to provide a context to better understand the software's intended uses and limitations. Because the application's user interface is not entirely self-explanatory, this report should be a valuable resource for VPV users, making it faster and easier to learn important features and use them effectively.

VPV is available on the World Wide Web at *http://ca.water.usgs.gov/program/sfbay/vpv/*. This report describes the version of VPV last modified on August 15, 2004.

Background

Acoustic Doppler current profiler (ADVM) measurement technology was developed in the late 1970s and early 1980s to remotely measure flow velocities of discrete layers of water at multiple locations in a vertical water column. When data from all layers are grouped at an instant in time, they form a velocity profile. Prior to this technology, mechanical current meters were the primary means of measuring time series of currents, but they only could collect data at a single point. Unfortunately, deploying mechanical meters in certain locations is not possible and it is not practical to deploy the number of meters necessary to completely cover the vertical range of water from bottom to surface.

In the 1980s, ADVM technology for deep-water ocean environments was adapted for the shallower depths of inland waterways. The USGS recognized the potential of ADVMs for measurement of currents in rivers and estuaries and became interested in acquiring and testing the devices (R. Billings, U.S. Geological Survey, written commun., 1985). The first USGS deployment of an upward-looking ADVM on the bottom of a body of water was in 1988 in San Francisco Bay (Smith and others, 1991; Burau and others, 1993). Since then, the USGS successfully has completed many such deployments in California and elsewhere (Smith and others, 1995; Burau and others, 1998; Gartner and Burau, 1999; Cuetara and others, 2001; Simpson, 2001). ADVMs send acoustic signals to record the speed and direction of water, generally at fixed vertical locations in a water column. Each vertical location is referred to as a bin, evoking the image of drawers stacked in a cabinet. Upward-looking ADVMs generally are deployed on a platform on the bottom of a body of water and they measure from the instrument to the surface. Downward-looking ADVMs measure from the surface to the bottom of a body of water and commonly are mounted on a boat. Discussions in this report generally will reflect the upward-looking view point.

The trend of increasing ADVM use has been accompanied by a similar trend of applying 3D hydrodynamic models to estuaries, lakes, and rivers (Cheng and Smith, 1990; Smith and Cheng, 1990; Smith and Larock, 1993; Smith, 1997). 3D-model simulations can generate data that are equivalent to the velocity profiles measured by ADVMs. Regardless of the data's source, visual display of the profiles is useful.

Visualization

Velocity data for a given location can be stored as speed and direction or as components of a vector. The axial, or U, component describes the speed along the principal direction of flow. The transverse, or V, component describes the speed perpendicular to the main axis. For example, if the principal direction of flow is along an east-west axis, then the transverse component would be along a north-south axis. The third component, which is aligned with the vertical axis, is typically ignored because of its relatively small magnitude.

Each ADVM in a monitoring network records a time series of velocity data for multiple bins, and 3D computer models can generate large quantities of spatially and temporally varying velocity data. With the advancement of data collection and simulation technology, the analysis and visual presentation of data has become increasingly challenging.

One way to present velocity data is to graph the U and V components, or speed and direction, versus time for each bin. This is simple to do and shows a complete record of the data, but requires significant effort to interpret and compare trends between bins. To make this task more intuitive, "stick plots" that show each vector as an angled line occasionally are used. Unfortunately, a stack of stick plots presents so much information on a single page that differences between bins at important times are not always obvious to the untrained eye.

It is most intuitive to view a velocity profile as a 3D drawing in space. It was possible in the late 1980s to develop software to create static figures containing a single velocity profile in 3D space (*fig. 1*) using the Computer Associates Disspla graphics software library. The data in each bin were shown as an arrow radiating from a vertical centerline and a projection was shown below the profile in the horizontal plane. These figures were used for analysis and in publications (Burau and others, 1993).

Although these static figures were ideal for printed publications, they forced the choice between displaying a simple 3D profile of one moment in time or displaying a more complete record of data in a series of graphs. Ideally, a time series of 3D profiles would be shown in succession, so a large amount of data could be presented in a more realistic graphic form.

The Dop3d Application

In the early 1990s, a software application called "dop3d" (*fig. 2*) was written to display velocity profile animation (J.R. Burau, U.S. Geological Survey, oral commun., 2002). Dop3d displayed velocity profile animation using a 3D graphics library called the IRIS Graphics Library (IRIS GL) (Kilgard, accessed July 15, 2004), which ran on Silicon Graphics, Inc. (SGI) workstations.

The dop3d application was valuable for its ability to display a moving picture of the velocity profile, which then could be used to preview or present data. Dop3ds animated, 3D graphics gave even casual viewers insight into the hydrodynamics of rivers and estuaries that otherwise was not possible. By the mid 1990s, dop3d, or a similar application, was in demand for use on the more popular Microsoft Windows platform. Unfortunately, IRIS GL was not available outside of SGI computers; therefore, dop3d was not easily portable.

The Velocity Application

In 1997, this author began developing "velocity," an application written in the C language (Kernighan and Ritchie, 1988) and using the Open Graphics Library (OpenGL) (OpenGL.org, accessed July 15, 2004), the open-platform successor to IRIS GL. OpenGL provides functions for drawing graphics, not for mouse and keyboard input. More powerful user-interface libraries such as Microsoft Foundation Classes (MFC) (Jones, 1999) were rejected in favor of the more portable Graphics Library Utility Toolkit (GLUT) (OpenGL.org, accessed July 15, 2004), which provides a very basic user interface, but allows the application's source code to be compiled without change for Windows, Unix, or other platforms.

In anticipation of wide distribution, "velocity" also was designed to be user-friendly. Commands could be chosen from a popup menu, and the animation and profile appearance could be controlled using the mouse or keyboard. By 1998, "velocity" nearly was implemented completely and renamed "Velocity Profile Viewer" ("VPV").

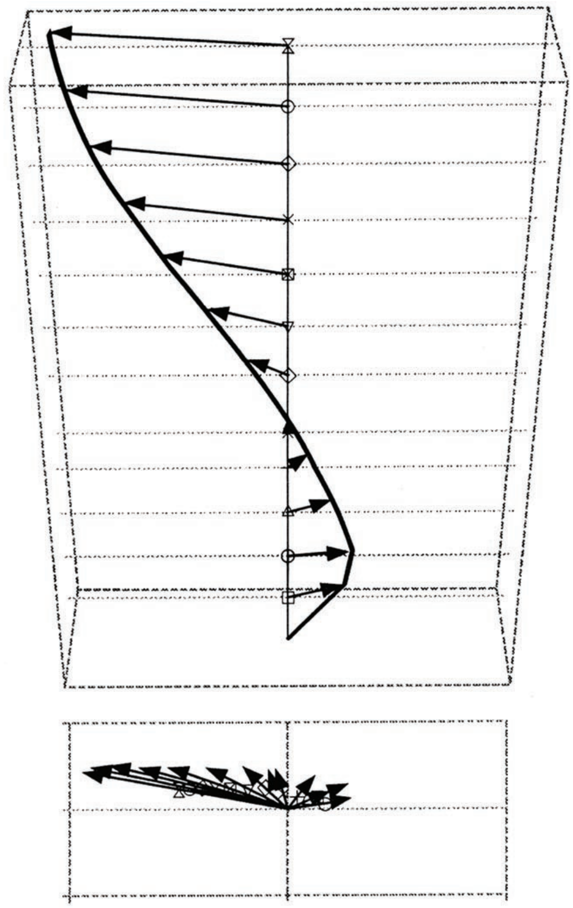


Figure 1. Example showing a velocity profile illustration created using the Computer Associates Disspla graphics software library (Burau and others, 1993).

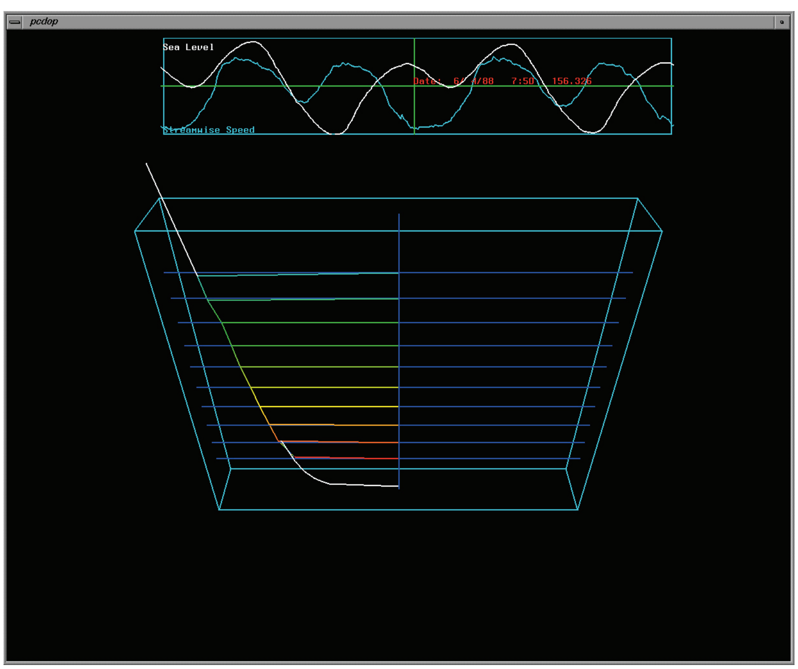


Figure 2. Velocity profile displayed by the dop3d application.

The Velocity Profile Viewer Application

Initially used by USGS research scientists studying the San Francisco Bay and Delta, VPV now is used by other USGS scientists, cooperating agencies, and engineers in private industry. Versions of VPV have been compiled for Windows and SGI IRIX platforms, and VPV can be compiled for other platforms that support C, OpenGL, and GLUT.

VPV reads the same data format that was developed within USGS for dop3d and other ADVM post-processing applications, and is described in *appendix 2* of this report. VPV provides more features than dop3d, such as graphs of the U and V component values for each bin, a variety of displays for the profile, and PostScript (Adobe Systems, Inc., 1985, 1990) output. However, VPV is a viewer only; it has no editing or data-saving capability. VPV opens a single data file, displays a single velocity profile, and animates that profile (*fig. 3*).

By default, VPV shows a 3D Profile View, which can be switched to a Bin Graph View using a mouse or keyboard command. The velocity profile is time-oriented and always corresponds exactly to one date and time. The animated profile is shown with arrows or a shaded surface to represent the U and V velocity vectors. The animation can be viewed interactively from any angle, paused, advanced by frame, or played at several different speeds.

Once a file is loaded successfully, the data for the first time step are displayed in the 3D Profile View. Instructions for installing and running VPV are given in *appendix 1*. VPV immediately shows the profile for each successive time, thus creating the illusion of animation. Once the animation begins, the user can pause the animation, switch to the Bin Graph View, or execute other commands. Minimizing the application prevents its playing forward or using any processor resources.

When the viewer advances, the Time and Time Step Number labels change, the three-dimensional profile is updated, and the Main Graph scrolls so that the point on its time axis that represents the present time step intersects the Time Marker Line. *Figure 4*A–D shows four sequential screen captures of VPV animation. The time required to play the sequence ranges from a fraction of one second to several seconds depending on the Time Step Increment and the speed of the computer. In *figure 4*A, the U components of the vectors range from slightly negative at the bottom of the profile to greatly negative at the top. In *figure 4*B, the U components of the vectors have become smaller in magnitude, although still negative. In *figure 4*C, the U components of the vectors are slightly positive at the bottom of the profile, while those at the top are slightly negative. In *figure 4*D, the U components of the vectors range from slightly positive at the bottom of the profile to greatly positive at the top.

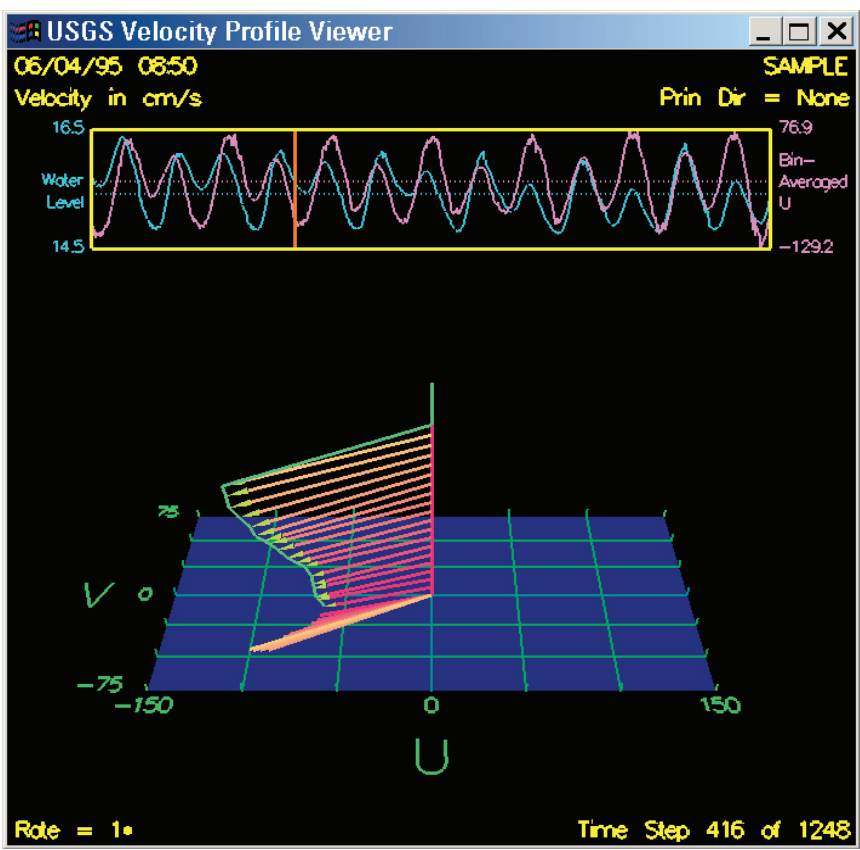


Figure 3. A three-dimensional profile displayed by the Velocity Profile Viewer.

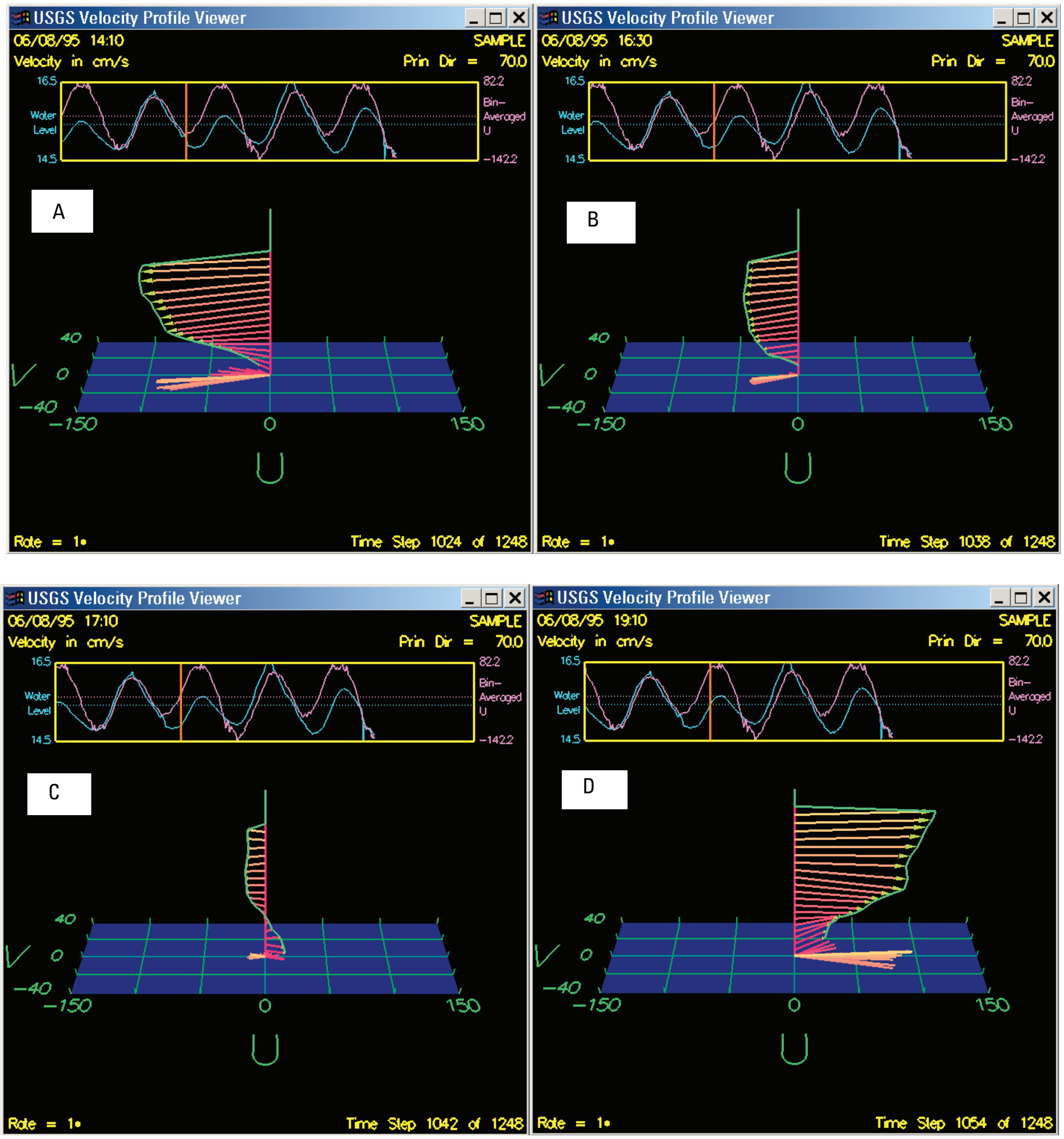


Figure 4. Four sequential frames of a sample profile animation displayed by the Velocity Profile Viewer. Each frame shown is for June 8, 1995. (A) Time step 1024 representing data at 14:10; (B) time step 1038 representing data at 16:30; (C) time step 1042 representing data at 17:10; and (D) time step 1054 representing data at 19:10.

Application Layout

VPV appears in a single window that can be toggled between a 3D Profile View and a Bin Graph View. Components of the 3D Profile View are shown and labeled in *figure 5*. Components of the Bin Graph View are shown and labeled in *figure 6*. The window does not contain a menu bar or use dialog boxes. The user interacts with the program by clicking and dragging the mouse, choosing commands from a popup menu (*fig. 7*), or by typing on the keyboard. For details, refer to the "Mouse and Keyboard Control" section of this report.

Most components of the 3D Profile View have fixed locations. The components fall into three categories: text information, 3D objects, and time-series graphs. The location of text information appears unchanged in the 3D Profile View and the Bin Graph View. 3D objects appear only in the 3D Profile View and include the velocity profile, grid, and axis. The Main Graph, which contains time-series curves of water-level and bin-averaged U velocity, appears in both views. The four graphs of individual bins appear only in the Bin Graph View.

The window can be resized by positioning the mouse pointer on the window border and dragging it to the desired

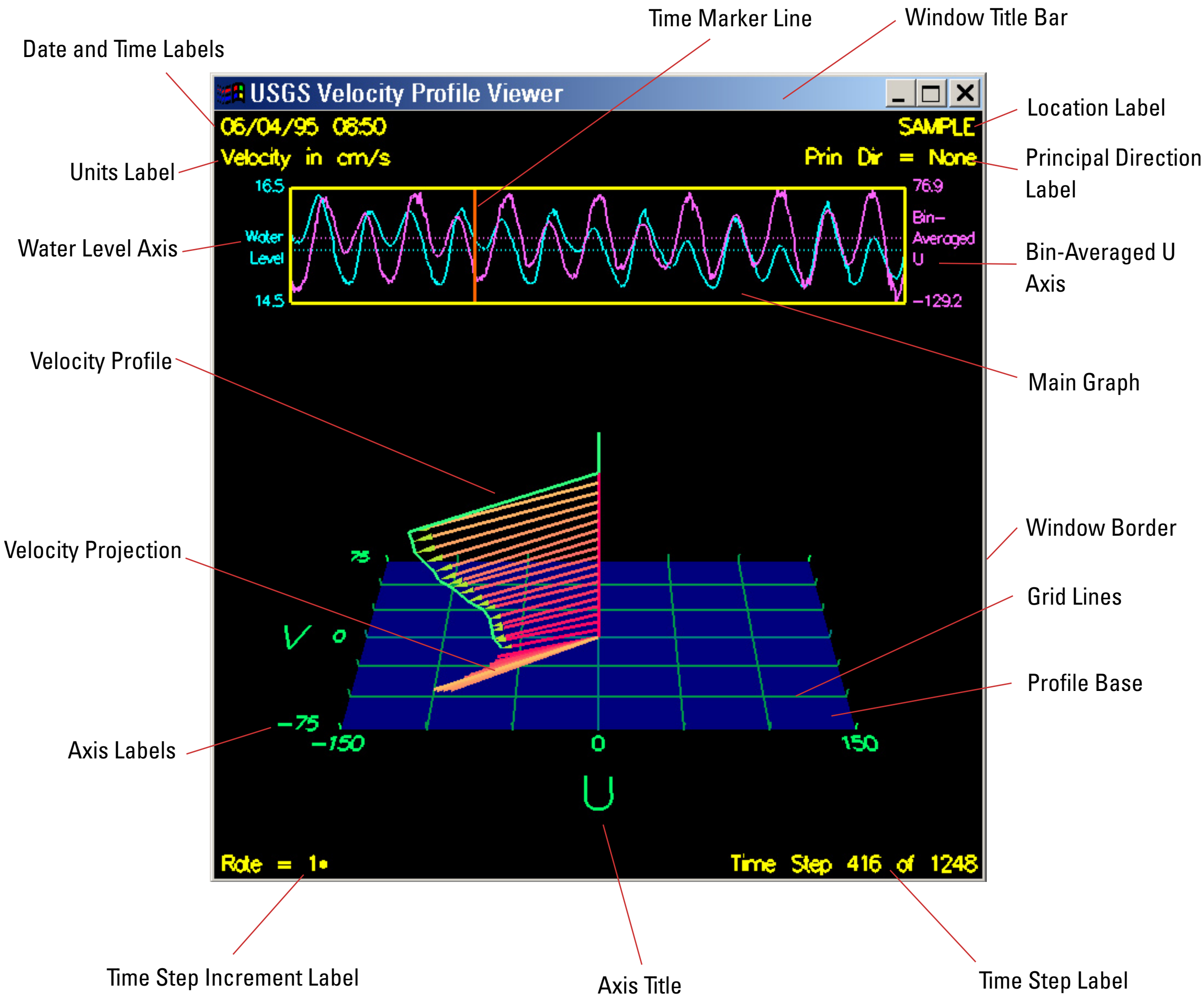


Figure 5. Components of the Three-Dimensional Profile View displayed by the Velocity Profile Viewer.

size. The contents of the window adjust to fit the new size; however, if the window is much wider than its height, or much higher than its width, the display will be distorted. *Figure 8* shows four different sized VPV windows displaying the same content, and shows resulting distortion.

To provide flexibility and to account for varying user preferences, VPV can show lines and text in thicknesses ranging from one to six pixels. When the VPV window is small, thin lines and text provide the necessary detail to resolve all the components. When the overall size of the window is large, such as would be used on a high-resolution monitor, the thin lines and text can become difficult to see. For more information on adjusting line thickness, see “View Commands” under the “Mouse and Keyboard Control” section of this report.

Text Information

Two lines of yellow text are at the top corners of the VPV window (*fig. 5*). The top left line displays the date and time of the measured or simulated data being shown in the velocity profile. The date and time advance with the animation. Immediately below this line is the label “Velocity in cm/s,” which indicates that centimeters per second are the units of the data displayed. The software cannot display an alternate units of measure label, but the label can be hidden if it is inappropriate for the data being viewed. The top right line displays a description of the location, as read from the data file header. This field does not change once the data file has been read. Immediately below this line is the principal direction of the U component. When the application starts, this value is “None”, but if the user chooses a new angle, the angle is shown in degrees, clockwise, from north. For more information on the principal direction, see “Orientation Commands” under the “Mouse and Keyboard Control” section of this report.

The yellow text in the bottom left corner of the VPV window displays the rate at which the animation is playing. The yellow text in the bottom right corner shows the present time step and the total number of time steps. Note that the actual colors that appear onscreen may vary depending on the settings for the monitor, display driver, or operating system color mode.

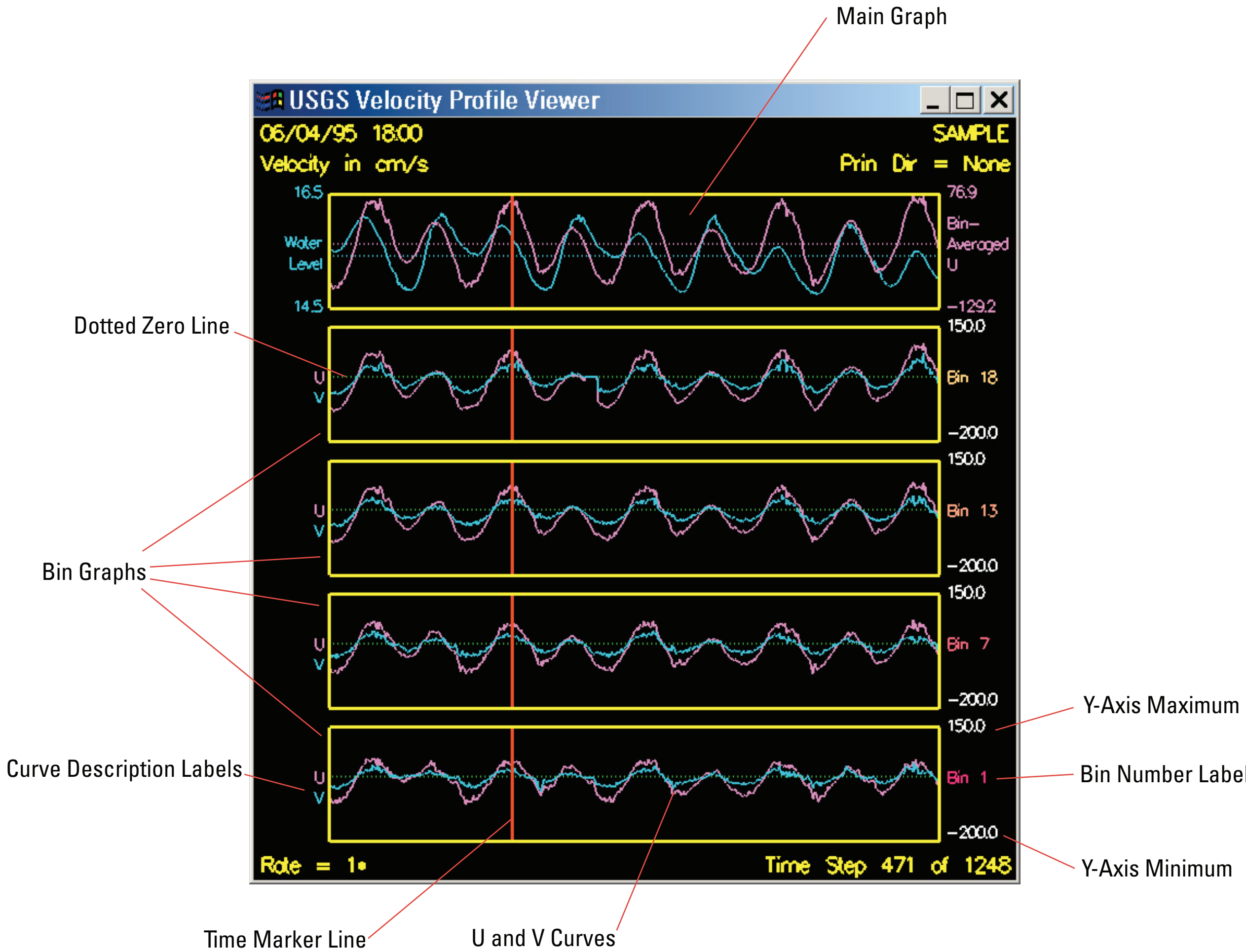


Figure 6. Components of the Bin Graph View displayed by the Velocity Profile Viewer. The Main Graph information labels are the same as the Three-Dimensional Profile View.

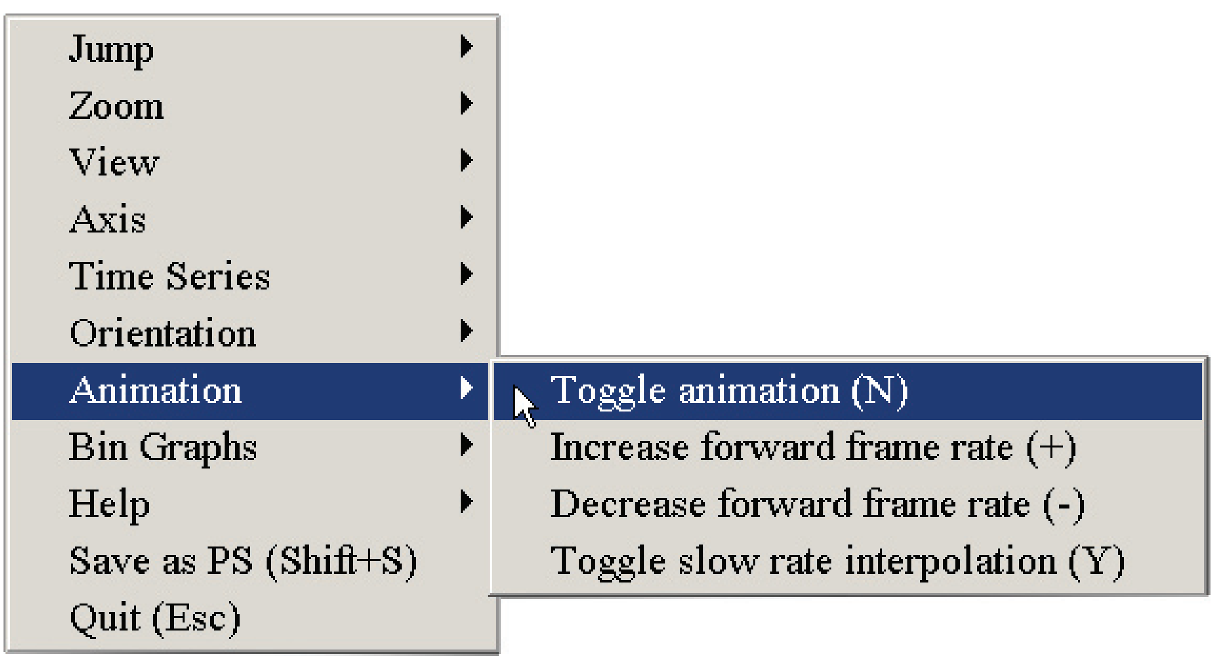


Figure 7. Popup menu showing the Animation submenu displayed by the Velocity Profile Viewer.

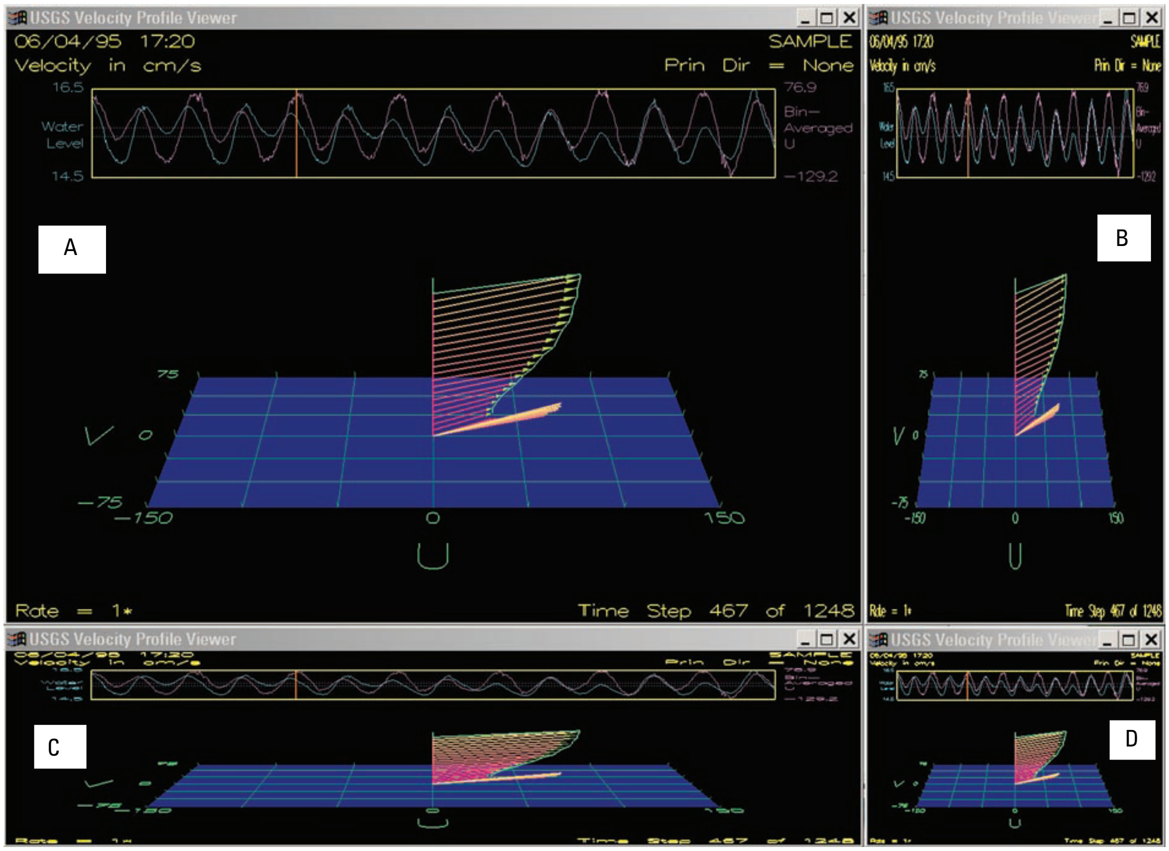


Figure 8. Four different sized Velocity Profile Viewer windows displaying the same content. The content always fills the window area, regardless of distortion. The windows are (A) relatively large (1184 x 855 pixels); (B) stretched vertically (415 x 855 pixels); (C) stretched horizontally (1184 x 305 pixels); and (D) relatively small (415 x 305 pixels).

The Main Graph

The Main Graph shows the mean U value of all the bins versus time (*fig. 5*). The mean value line in the graph is magenta and is labeled as Bin-Averaged U. The vertical scale is indicated by magenta axis labels at the two right corners of the graph. The horizontal scale is not indicated, but the value where the graph intersects the Time Marker Line is always written in the date and time labels. The mean of the bin-averaged U velocity over all the time values is a magenta horizontal dotted line.

When water-level data are provided in the input file, they are shown as a cyan line in the Main Graph with no assumptions made regarding units or datum. The axis label and title on the left edge of the graph also are cyan, and the mean of the water-level curve is a cyan horizontal dotted line.

Three-Dimensional Profile View

The 3D Profile View is the standard view in VPV and shows the data as a 3D velocity profile (*fig. 5*) with the Main Graph at the top and descriptive yellow text in each corner of the window. The 3D velocity profile displays a red, vertical line with arrows radiating perpendicularly to it at regularly spaced vertical intervals. Each arrow consists of a shaft with a flat, vertically aligned yellow-green arrowhead. The size of the arrowhead fluctuates with the length of the shaft. Depending on user preference, all arrow shafts may be red, or they may vary from yellow at the top to red at the bottom.

A green line connects the arrow tips of all the bins defined in the data file. If a bin has a velocity of zero for a given time step, the arrow tip and the green line are located on top of the center line. This can be seen when displaying data sets in which tidal variation causes the water surface to drop below the top bin. The effect is a green outline that stretches from the top of the highest nonzero arrow back to the center line at the bin above it. If all the bins have a velocity of zero, the centerline will appear green where it is covered by the green outline.

The profile base consists of a flat, blue rectangle in the U-V plane and an optional grid with tick marks that can be shown on the rectangle. Axis labels are shown along the bottom and left side of the grid area. The vertical space interval between the profile base and the lowest arrow is equal to the space between the other arrows.

An optional velocity projection is shown on the base to show the spread of vectors in the U-V plane. This causes the profile arrows and surface to be shown with a height-variable

color scheme that fades from yellow at the top to red at the bottom. The color of each projected line matches the color of the line directly above it on the profile, thus allowing the user to determine the bin represented by each projected line.

A shaded surface also may be shown on the profile to give it the appearance of a flag flying from a pole. The surface is shaded blue and illuminated by a virtual light to reveal its shape.

Bin Graph View

The Bin Graph View displays the velocity data in four vertically stacked graphs below the Main Graph (*fig. 6*). By default, each graph displays a different bin, with the bottom graph showing data from the first bin, and the top graph showing data from the last bin. The two middle graphs show data from bins at roughly equally spaced intervals in the middle of the profile. The arrangement can be changed from the default so that any graph displays data for any bin using the Bin Graphs/Increase and Bin Graphs/Decrease commands, which are described in the “Bin Graphs Commands” sub section in the “Mouse and Keyboard Control” section of this report. The bin number is shown to the right of each graph in the same color, varying from yellow to red, as the bin’s arrow in the 3D profile.

The horizontal scale is the same as for the Main Graph at the top of the window. The vertical scale is the same for all bins shown so that relative magnitude can be determined. The limits are rounded to the nearest increment of 5, 10, 25, or one of those numbers multiplied by a power of 10. The minimum and maximum values of each vertical axis are shown near the right corners of each of the four graphs.

By default, the Bin Graph View shows stick plots of bins, which represent the vector at each time step as an angled line (*figs. 9*A–C). The height of the line represents the U component, and the horizontal offset of the endpoint represents the V component. “Sticks” with positive V values angle to the left, whereas those with negative V values angle to the right. The V scale for sticks is dependent on the time span shown within the graph, so it is not the same as the U scale. The sticks may appear to be extremely skewed if the principal direction has not been set correctly (*fig. 9*B). For information about the principal direction, see the “Orientation Commands” section in the “Mouse and Keyboard Control” section of this report. If the time span is expanded, some sticks will be omitted to avoid overcrowding in the graph (*fig. 9*C).

The U and V components can be shown as separate curves on the bin graphs. The U curve is shown in magenta

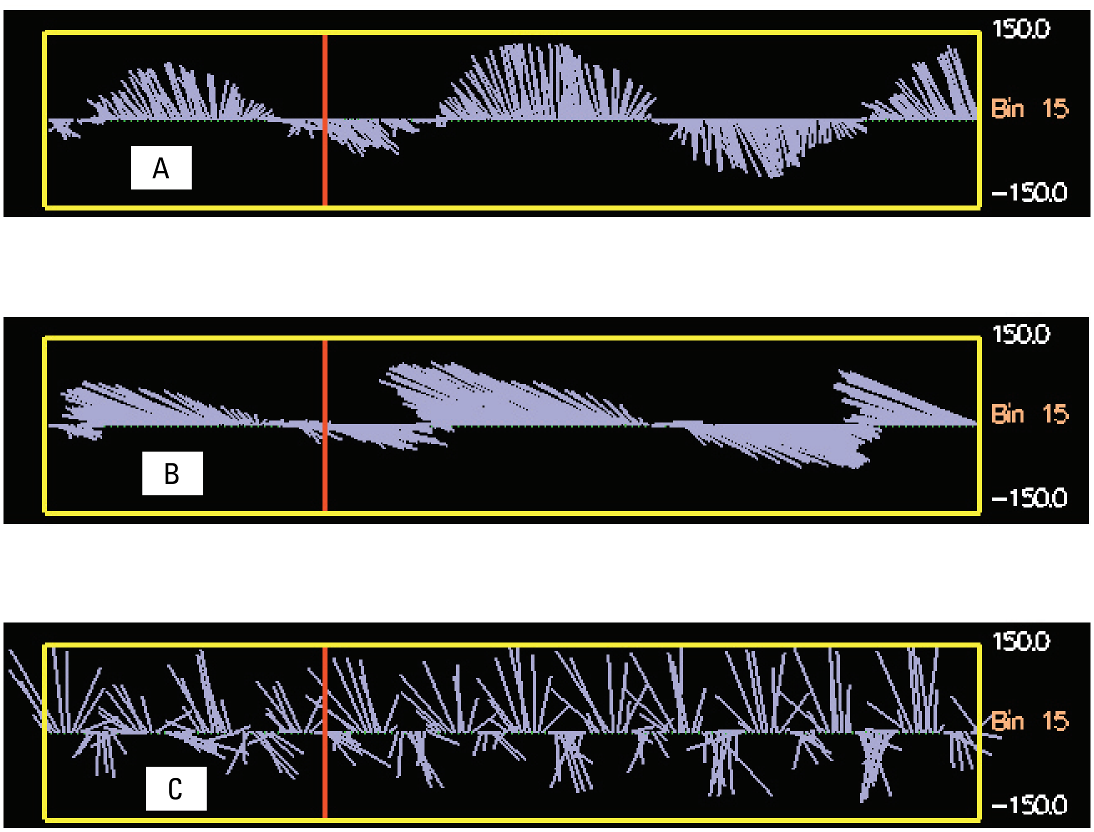


Figure 9. Three different displays of the same bin from the Bin Graph View in the Velocity Profile Viewer. The sticks are (A) easy to discern; (B) skewed because the principal direction is not set; (C) sparse because the time span has been expanded.

and the V curve is shown in cyan (*fig. 6*). When the principal direction is properly aligned, the V curve is minimized and the U curve is maximized (*fig. 9*A).

Whether showing sticks or component curves, each bin graph always has a green, dotted horizontal line. Rather than representing the mean, as do the dotted lines on the Main Graph, this green dotted line represents zero on the vertical axis. For further information on bin graph properties, see the “Bin Graphs Commands” sub section in the “Mouse and Keyboard Control” section of this report.

Mouse and Keyboard Control

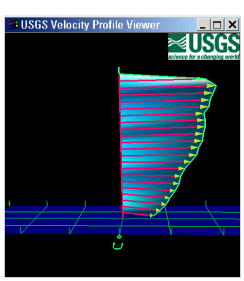
Left Mouse Button Control

Much of the user interaction with VPV involves “dragging” the mouse, which is defined as holding down the left mouse button while moving the mouse. The application’s response depends on which, if any, meta-keys are held down on the keyboard while dragging the mouse.

Mouse Control in the Three-Dimensional Profile View

If no keys are held down, and the mouse pointer is not on the Main Graph when the left mouse button is pressed, the profile will rotate in tandem with the movements of the mouse. This allows the profile to be viewed from any angle (*fig. 10*A–D). The rotation works in a similar way to a trackball input device where the directional movement of one’s hand causes the rotation of the ball. In VPV, clicking on the left side of the profile and dragging the mouse to the right will rotate the left side of the profile around to the front. Clicking at the top of the profile and dragging the mouse down will rotate the top of the profile down to show the top view. (See “*vpv_rotation.avi*” video)

Holding down the Alt key while dragging the mouse vertically will scale the profile larger or smaller. Holding down the Shift key while dragging the mouse vertically will reposition the profile vertically. Holding down the Ctrl key while dragging the mouse in the 3D Profile View will cause the profile to continue rotating even after the mouse button is released. The rotation speed and direction are determined by the speed and direction in which the mouse was dragged.



VPV Rotation Video.

Mouse Control in the Main Graph

If the left mouse button is pressed when the cursor is within the Main Graph, the present time step will change as the mouse is dragged. Dragging the mouse to the left pans the graph to the left and advances the time step. Dragging the mouse to the right pans the graph to the right and moves the time step backward (see “*vpv_timedrag.avi*” video). Holding down the Ctrl+Alt keys will force this behavior, even if the cursor is outside the Main Graph.

Mouse Control in the Bin Graph View

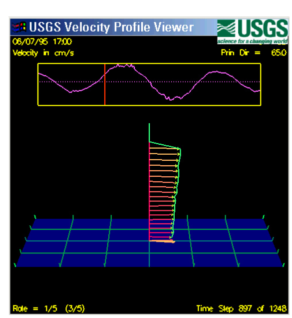
When in the Bin Graph View, dragging the mouse left and right causes the graphs to pan and the present time step to be moved forward or back, just as it does on the Main Graph in the 3D Profile View. This behavior happens in the Bin Graph View no matter where the cursor is placed when the left mouse button is clicked.

Holding down the Alt key while dragging the mouse vertically changes the scale of the y-axes. Holding down the Shift key while dragging the mouse vertically translates all the graphs along their y-axes. Whether scaling or shifting, each vertical axis label advances to the nearest round number. The Bin-Averaged U graph also translates, although its axis limits are not rounded.

Right Mouse Button Commands

Clicking the right mouse button when the cursor is anywhere in the VPV window causes a popup menu to appear next to the mouse pointer (*fig. 11*). On the Windows operating system, the animation freezes when the popup menu is displayed, whereas on Unix, the animation continues. The menu contains the following submenus: Jump, Zoom, View, Axis, Time Series, Orientation, Animation, Bin Graphs, and Help.

Commands are shown on each submenu and at the bottom of the main menu. The user can execute the desired command by selecting it with the mouse. Since frequently used commands are practical only when using the keyboard, the popup menu often is most useful as a reference to help remember the command-key associations. The commands are described in the “Keyboard Commands” section of this report.



VPV Timedrag Video.

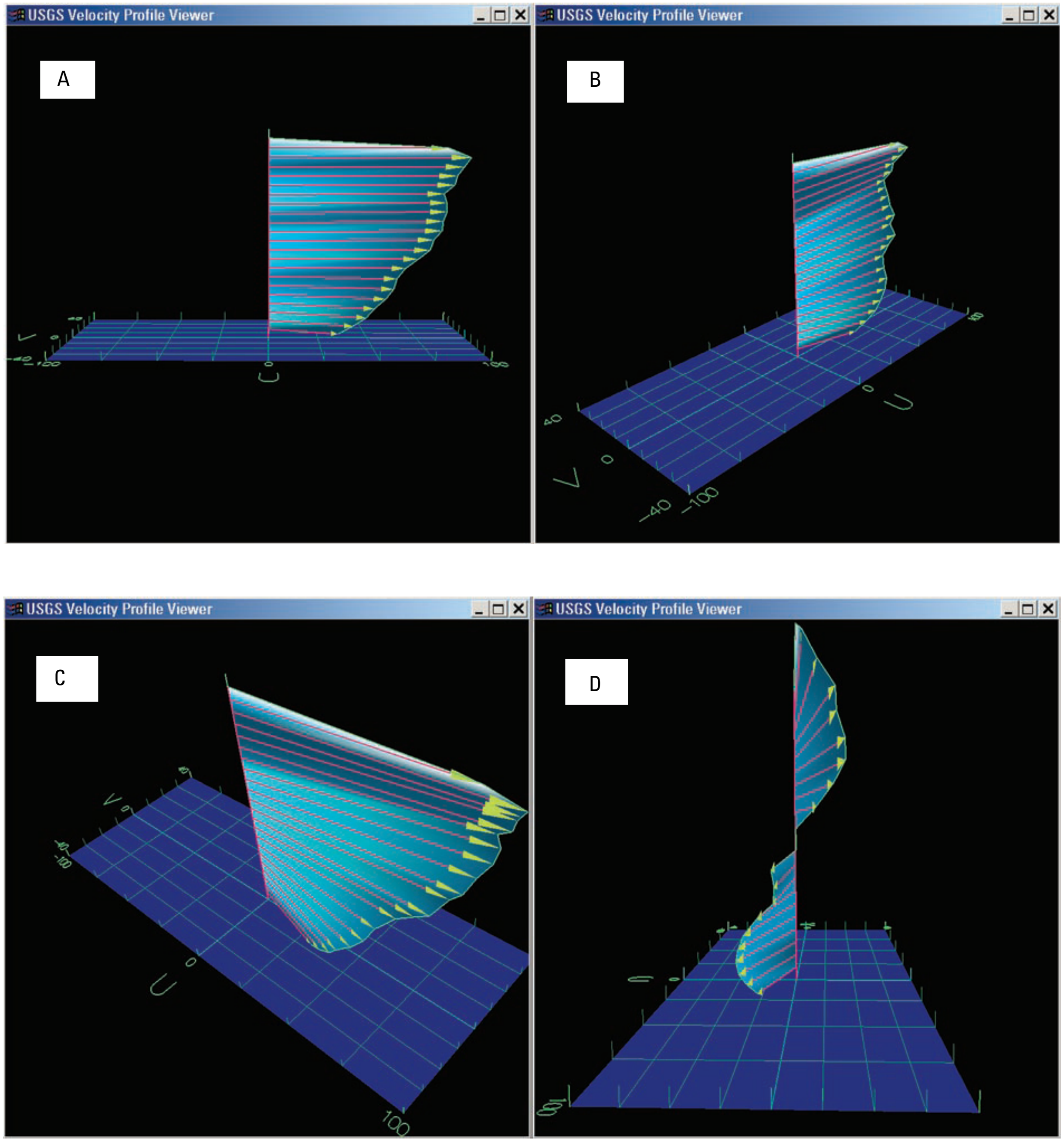


Figure 10. Four views of the same velocity profile in the Velocity Profile Viewer from different angles. The profile viewing angle is from (A) the front, looking straight across; (B) the front, left side, looking slightly downward; (C) the front, right side, looking sharply downward; and (D) the right side, looking slightly upward.

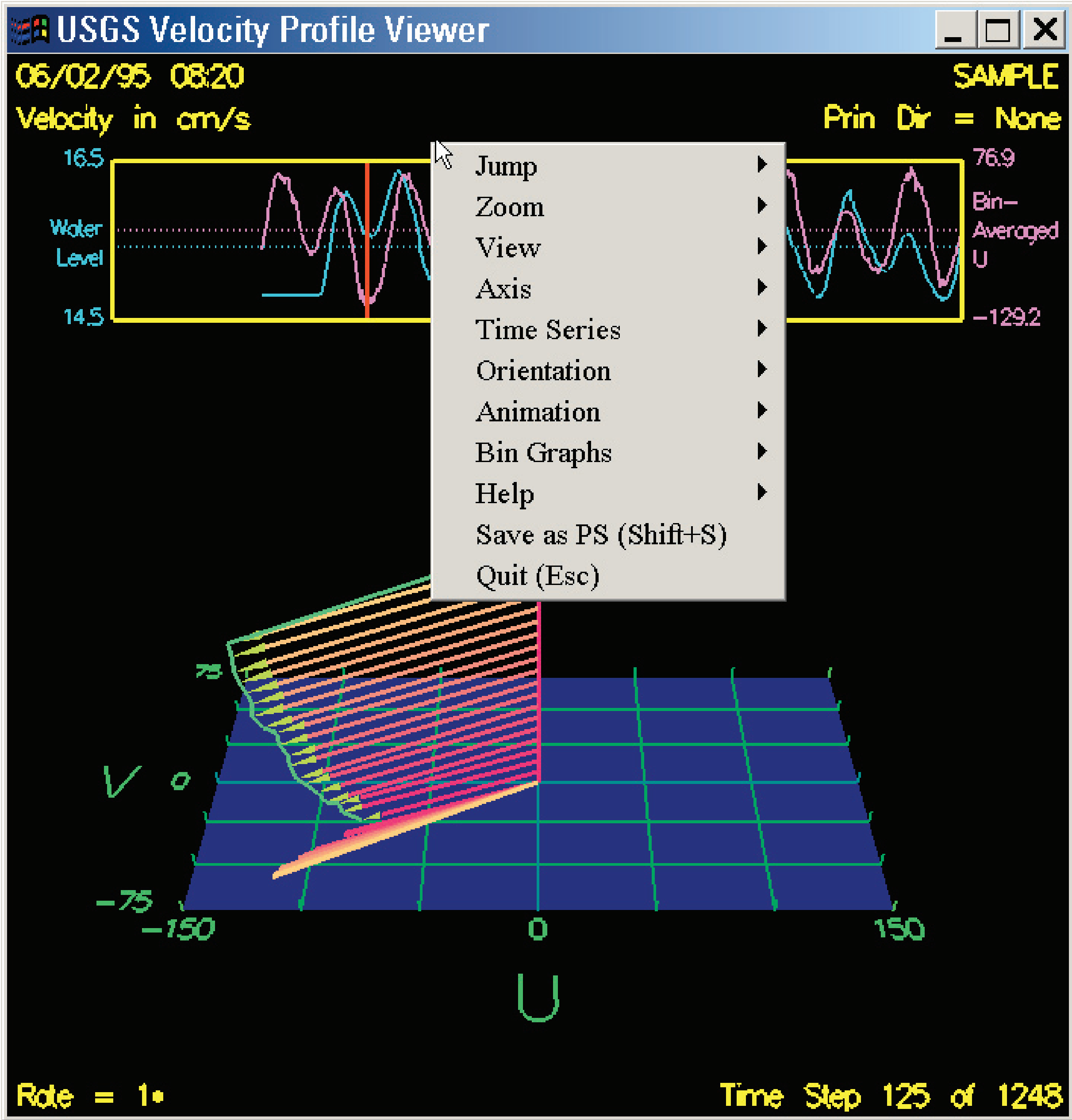


Figure 11. The Velocity Profile Viewer as it looks after clicking the right mouse button anywhere in the window. A popup menu appears next to the mouse pointer.

Keyboard Commands

All popup menu commands are available as keyboard shortcuts, with the corresponding key shown in parentheses next to each command on the menu. The user can find the desired command key by looking on the menu and later execute the command by typing that key. The following subsections correspond to submenus on the popup menu. The commands work identically, regardless of whether they are issued using the keyboard or the mouse.

Jump Commands

Jump commands are used to look at a different part of the time series. The commands can be given while animation is running or stopped. *Table 1* describes the commands on the Jump menu.

Zoom Commands

Zoom commands differ from scaling using the mouse and Alt key. Scaling with the mouse changes the size of the profile, as well as the 3D axis labels and titles. Scaling with the zoom commands changes only the size of the profile. These commands are useful when the 3D axis labels are the correct size but the profile is too large or small. When viewing the bin graphs, these commands change the limits of the y-axes. *Table 2* describes the commands on the Zoom menu. *Figures 12* and *13* show the effects of zooming out and in, respectively.

Table 1. Commands on the Jump menu of the Velocity Profile Viewer.

Command Key	Command Description
0 (zero)	Jumps to the beginning of the time series.
F	Jumps forward 1 time step. This can be used to manually advance the time step when the animation is stopped.
Shift+F	Jumps forward 10 time steps.
H	Jumps forward 100 time steps.
T	Jumps forward 1,000 time steps.
B	Jumps backward 1 time step.
Shift+B	Jumps backward 10 time steps.
Shift+H	Jumps backward 100 time steps.
Shift+T	Jumps backward 1,000 time steps.

Table 2. Commands on the Zoom menu of the Velocity Profile Viewer.

[See *figures 12-13* for examples]

Command Key	Command Description
I	In the 3D Profile View, moves the viewpoint slightly closer to the profile.
	In the Bin Graph View, shows a slightly smaller span on the Y axis.
Shift+I	In the 3D Profile View, moves the viewpoint much closer to the profile.
	In the Bin Graph View, shows a much smaller span on the Y axis.
O	In the 3D Profile View, moves the viewpoint slightly farther from the profile.
	In the Bin Graph View, shows a slightly larger span on the Y axis.
Shift+O	In the 3D Profile View, moves the viewpoint much farther from the profile.
	In the Bin Graph View, shows a much larger span on the Y axis.

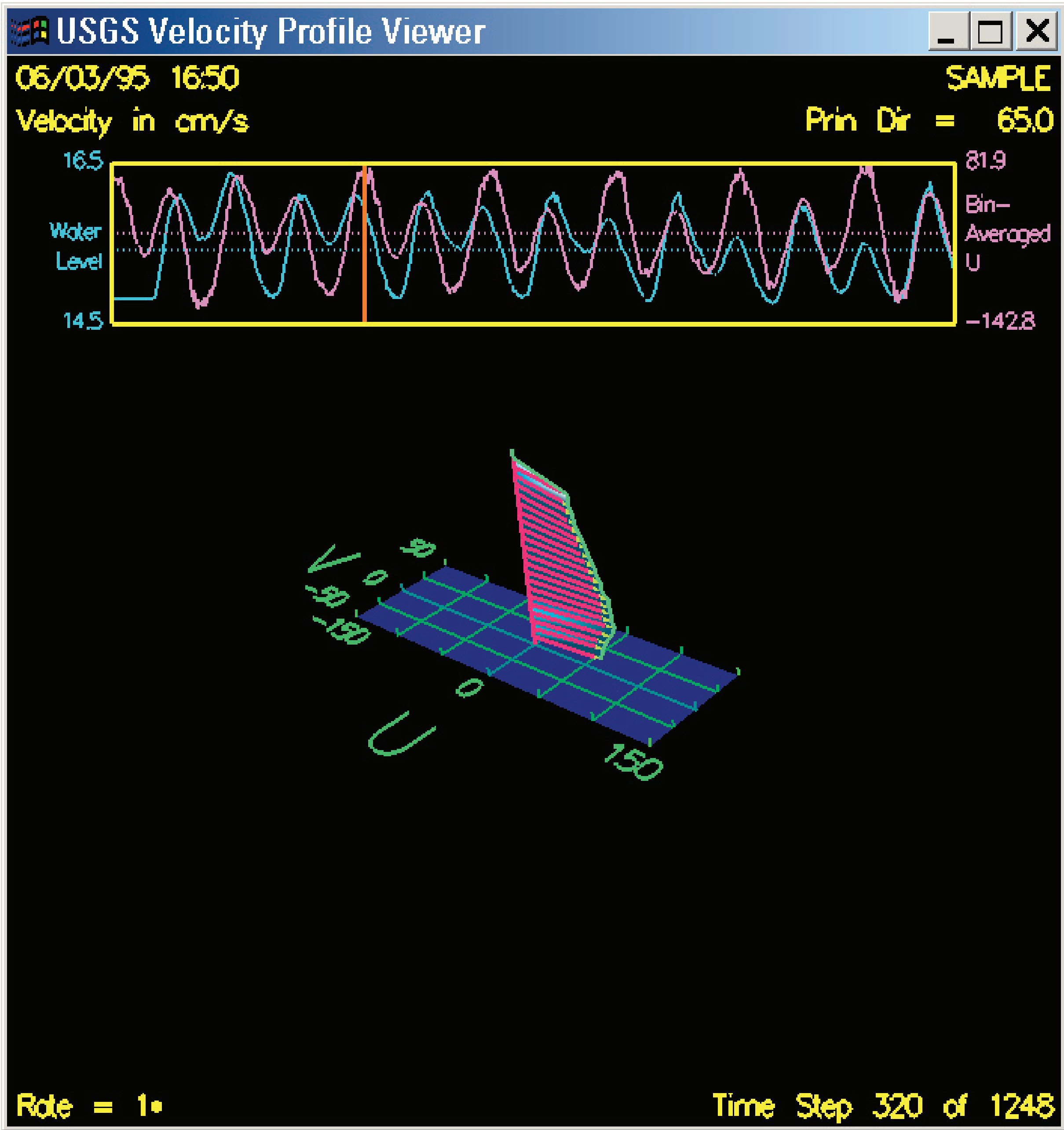


Figure 12. The Three-Dimensional Profile View of the Velocity Profile Viewer after zooming out far from the profile.

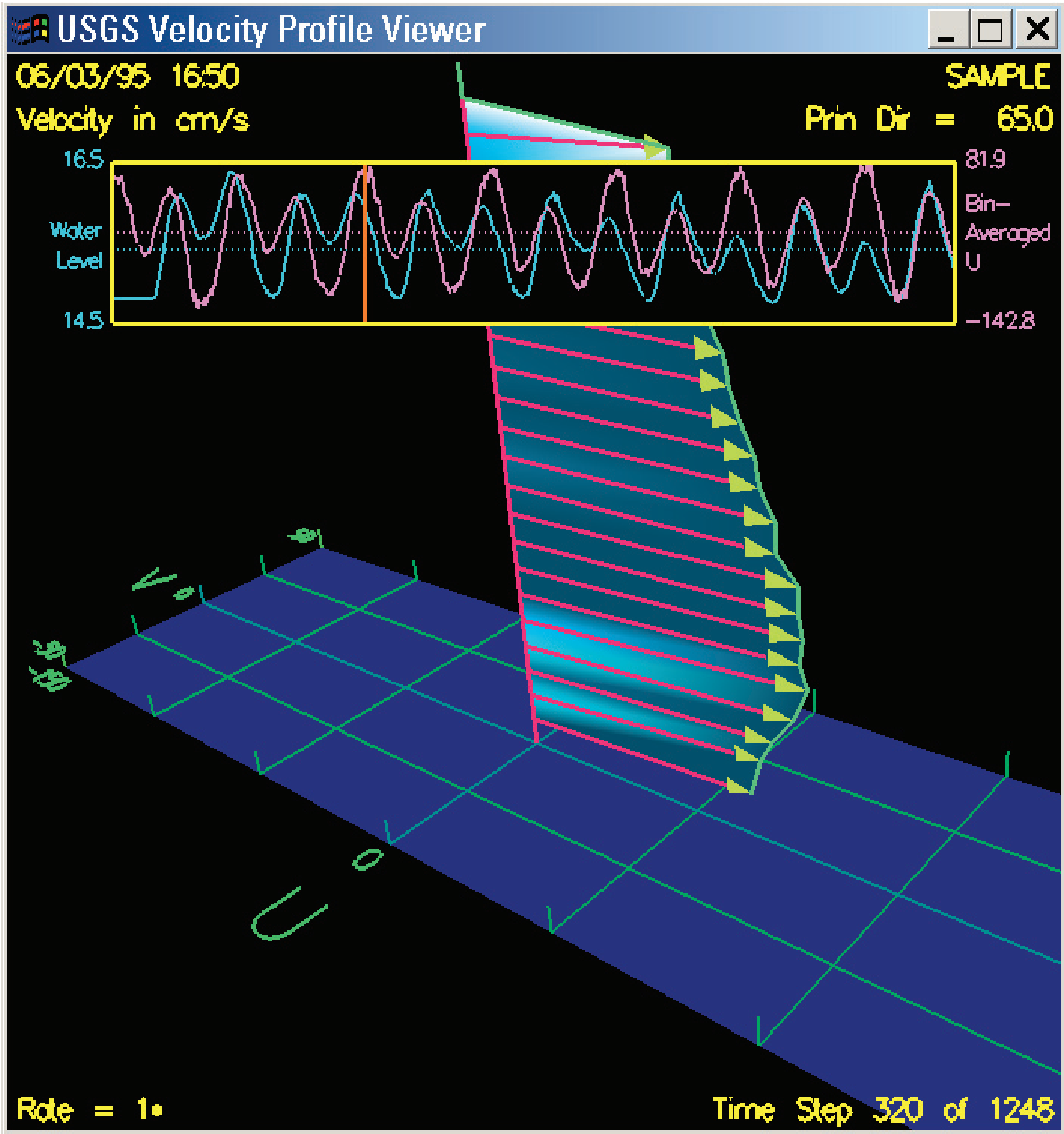


Figure 13. The Three-Dimensional Profile View of the Velocity Profile Viewer after zooming in close to the profile. This view shows that any portion of the profile that encroaches on the Main Graph area is blocked from view.

View Commands

View commands control the appearance of the profile and the presentation of text information. *Table 3* describes the commands on the View menu. *Figures 14* and *15* show the effects of the View Menu commands “S”, “A”, and “C” (*table 3*) on the 3D profile, which toggle a smooth-shaded surface, vector arrows, and the color projection, respectively. *Figure 16* shows the effects of the View commands “G”, “1”, “2”, “3”, and “4” on the profile base and text information, which toggle the first, second, and bottom lines of text, axis labels and titles, and an axis grid (*table 3*), respectively. *Figure 17* shows the effect of the Julian date command, command “J”, which toggles the format of the date label between standard month/day and Julian day.

Table 3. Commands on the View menu of the Velocity Profile Viewer.

[Most of these commands act as toggles; issuing the command a second time will restore the original state. When changing text and line width, issuing the command six times will cycle back to the original state. See *figures 14-24* for examples]

Command Key	Command Description
S	Shows the 3D profile with a lit, smooth-shaded surface (shown in *figs. 14-15*).
A	Shows the 3D profile with vector arrows (shown in *figs. 14-15*).
C	In the 3D Profile View, makes the arrow or surface segment for each bin a different color. Projects the colors onto the profile base to show the relative speed and direction in the horizontal plane (shown in *figs. 14-15*). In the Bin Graph View, draws a blue-to-black fade for the background for easier distinction between graphs. Improves appearance at the expense of frame rate (shown in *figs. 34-35*).
L	Uses anti-aliasing to make lines and text smoother and less jagged. Antialiasing reduces sharpness, but generally improves the appearance of diagonal lines. Thin lines and text may look blurry. Appearance and performance vary depending on hardware configurations (shown in *figs. 23-24*).
1	Shows the first line of text information including date, time, and location labels. (shown in *fig. 16*).
2	Shows the second line of text including the units and principal direction labels (shown in *fig. 16*).
3	Shows the bottom line of text including the time-step increment and time step labels (shown in *fig. 16*).
4	Shows axis labels and titles on the 3D profile and time-series graphs (shown in *fig. 16*).
G	In the 3D Profile View, shows a grid on the base of the 3D profile (shown in *fig. 17*).
J	Shows the date in Julian format rather than the usual month/day/year format.
R	In the 3D Profile View, resets the profile’s position, rotation, scale, and zoom to their original values. In the Bin Graph View, resets the zoom and vertical translation.
U	Makes the window full screen and hides the window title bar and borders.
Shift+1	Increases the thickness of small text by one pixel. Once the thickness reaches six pixels, it cycles back to one pixel (see *figs. 18-24*).
Shift+2	Increases the thickness of large text by one pixel. Once the thickness reaches six pixels, it cycles back to one pixel (see *figs. 18-24*).
Shift+3	Increases the thickness of thin lines by one pixel. Once the thickness reaches six pixels, it cycles back to one pixel (see *figs. 18-24*).
Shift+4	Increases the thickness of wide lines by one pixel. Once the thickness reaches six pixels, it cycles back to one pixel (see *figs. 18-24*).

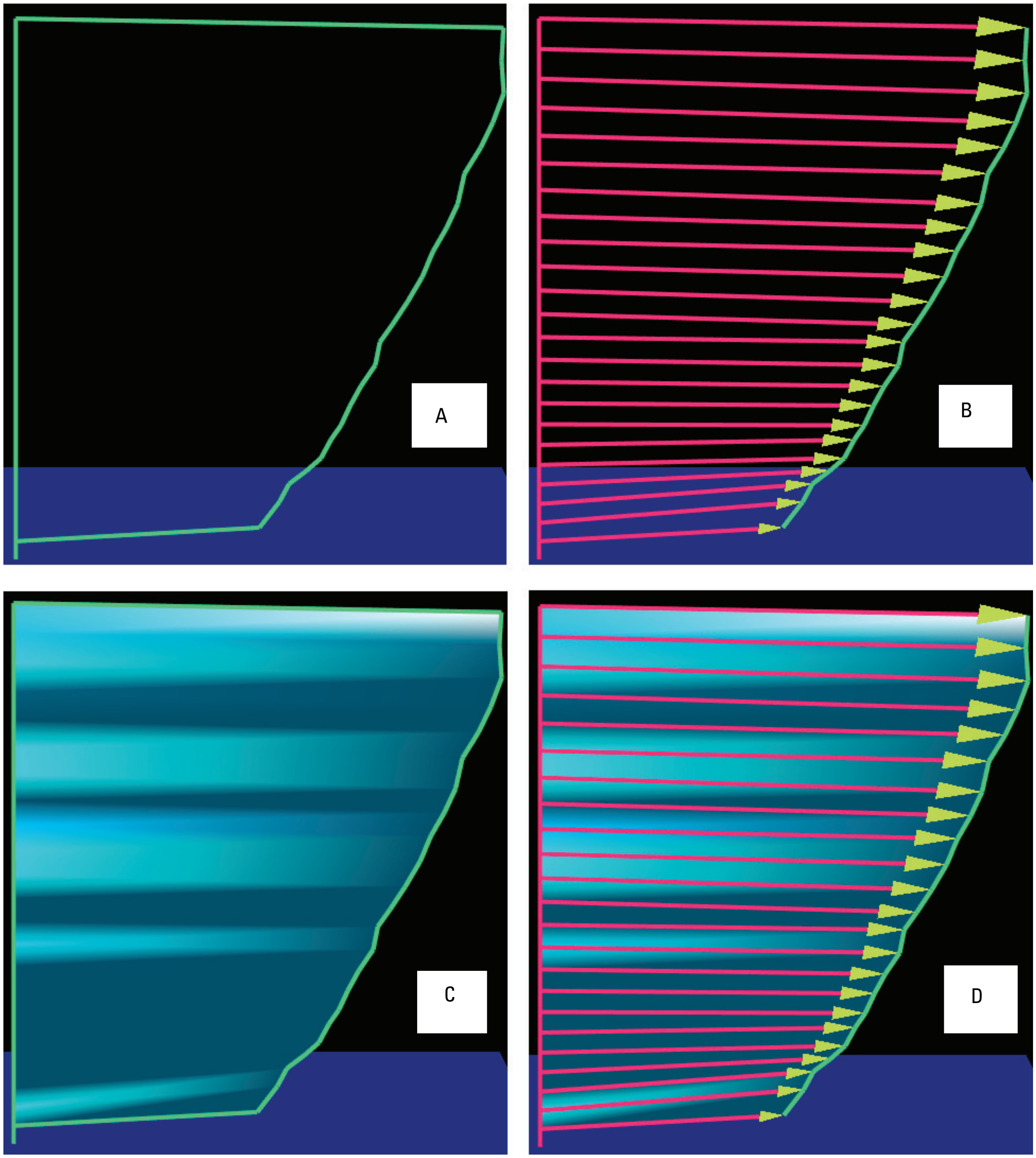


Figure 14. Four different displays of the Three-Dimensional Profile View of the Velocity Profile Viewer with the color projection turned off.
(A) arrows and surface turned off; (B) arrows turned on and surface turned off; (C) arrows turned off and surface turned on; and (D) arrows and surface turned on.

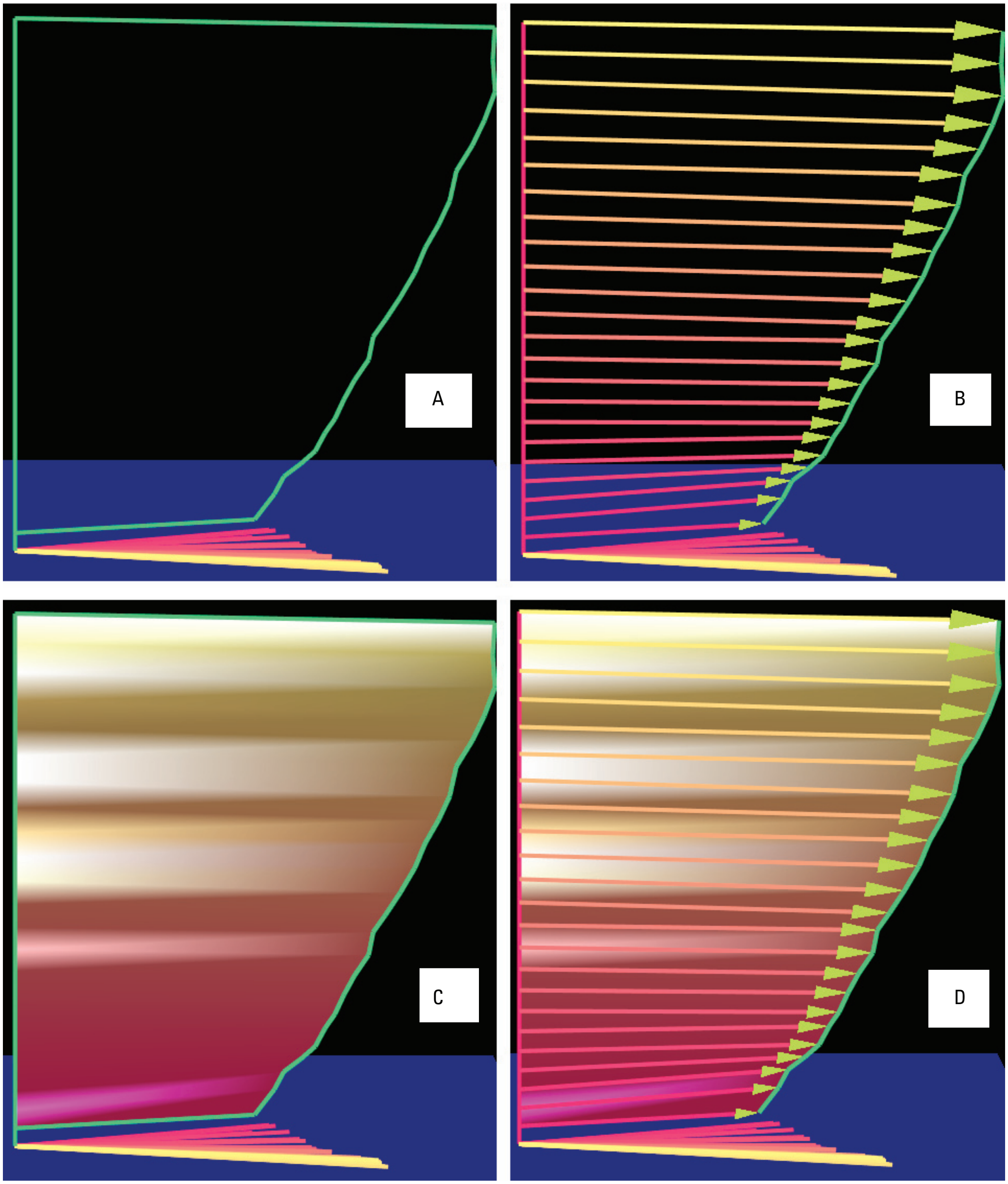


Figure 15. Four different displays of the Three-Dimensional Profile View of the Velocity Profile Viewer with the color projection turned on.
(A) Arrows and surface turned off; (B) arrows turned on and surface turned off; (C) arrows turned off and surface turned on; and (D) arrows and surface turned on.

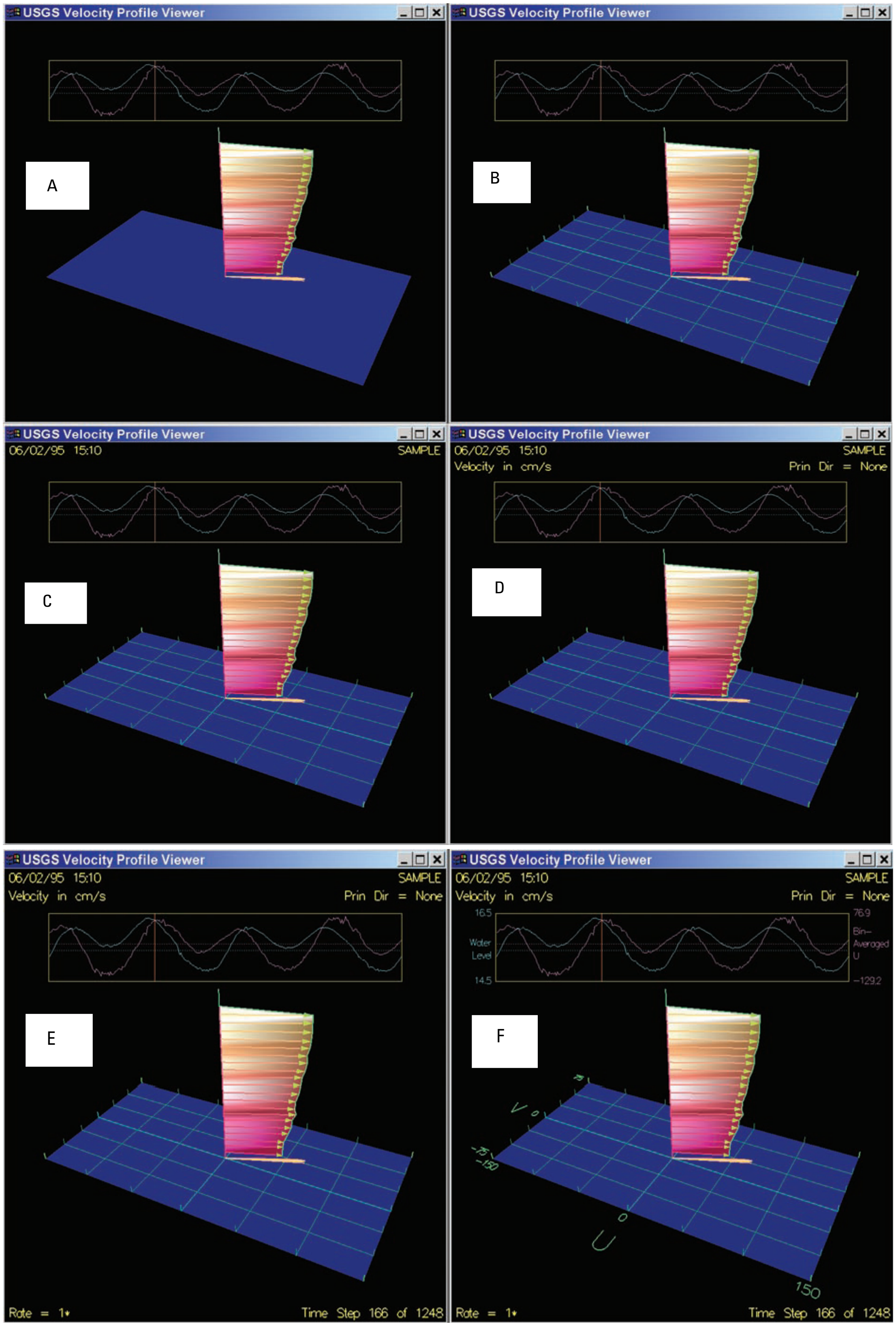


Figure 16. Screen captures of the Velocity Profile Viewer showing variations of the Three-Dimensional Profile View components. (A) devoid of text
second lin
step; and (F) with axis labels next to the three-dimensional profile grid and the Main Graph.

The View menu also has commands for controlling the line weight of small text such as the axis labels (Shift+1, *table 3*), large text such as the date and location (Shift+2, *table 3*), narrow lines such as the curves on graphs (Shift+3, *table 3*) and wide lines such as the 3D profile's arrow lines (Shift+4, *table 3*). Possible combinations include, but are not limited to, a large-sized window and wide line weight (*fig. 18*), a medium-sized window and wide line weight (*fig. 19*), a medium-sized window and medium line weight (*fig. 20*), a medium-sized window and narrow line weight (*fig. 21*), and a small-sized window and narrow line weight (*fig. 22*). Each time a command to change line weight thickness is given, the width is increased by one pixel. Once the thickness reaches six pixels, giving the command sets the thickness back to one pixel. *Figures 23* and *24* show, in detail, the effects of the commands for controlling antialiasing and line and text thickness.

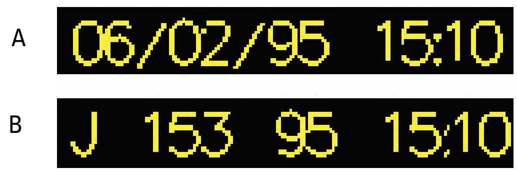


Figure 17. Screen captures of the date "June 2, 1995, at 3:10 p.m." in (A) standard and (B) Julian format.

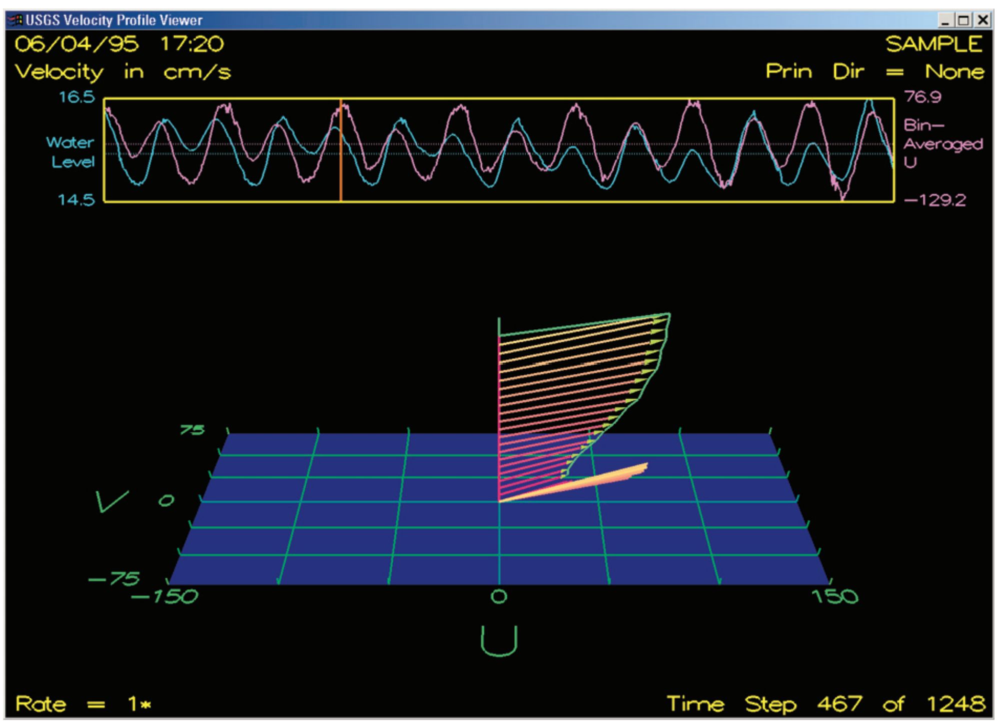


Figure 18. The Velocity Profile Viewer showing the proportions of lines and text when using a large-sized window and wide line weight.
The window size is 1599 x 1161 pixels. The lines are 4 pixels wide for small text and thin lines and 5 pixels wide for large text and wide lines.

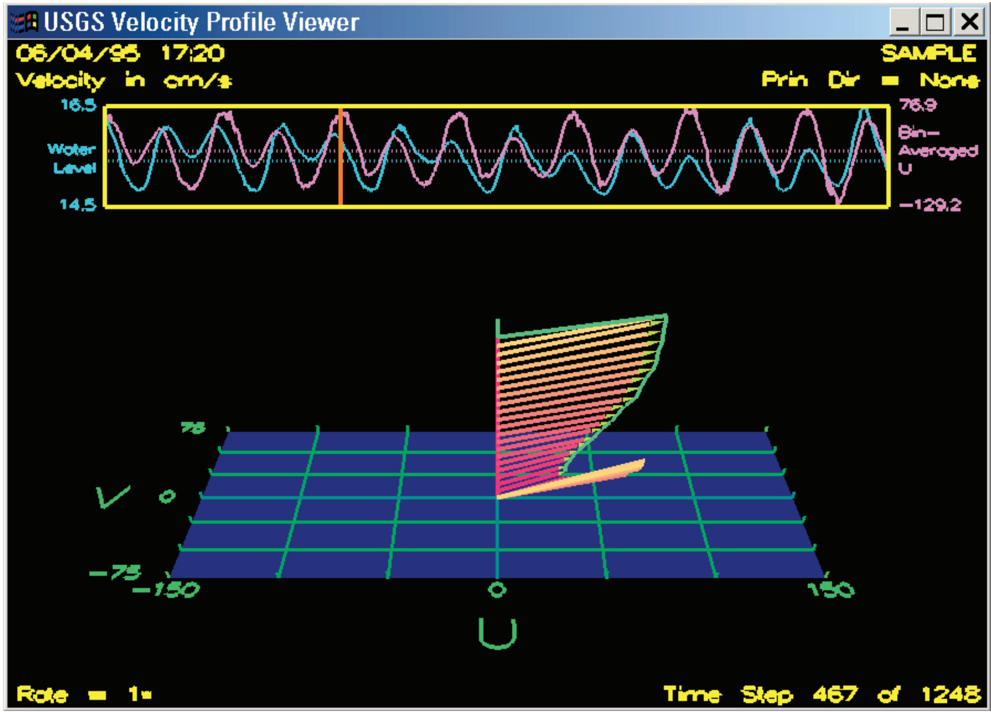


Figure 19. The Velocity Profile Viewer showing the proportions of lines and text when using a medium-sized window and wide line weight.
The window size is 893 x 640 pixels. The lines are 4 pixels wide for small text and thin lines and 5 pixels wide for large text and wide lines.

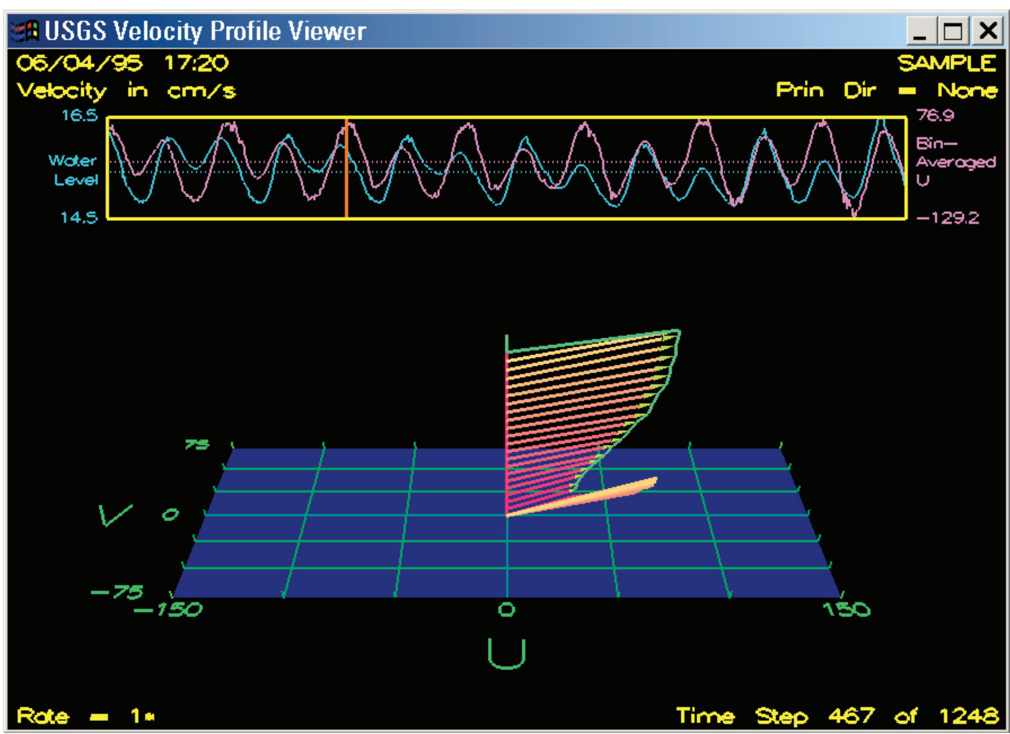


Figure 20. The Velocity Profile Viewer showing the proportions of lines and text when using a medium-sized window and medium line weight.
The window size is 893 x 640 pixels. The lines are 2 pixels wide for small text and thin lines and 3 pixels wide for large text and wide lines.

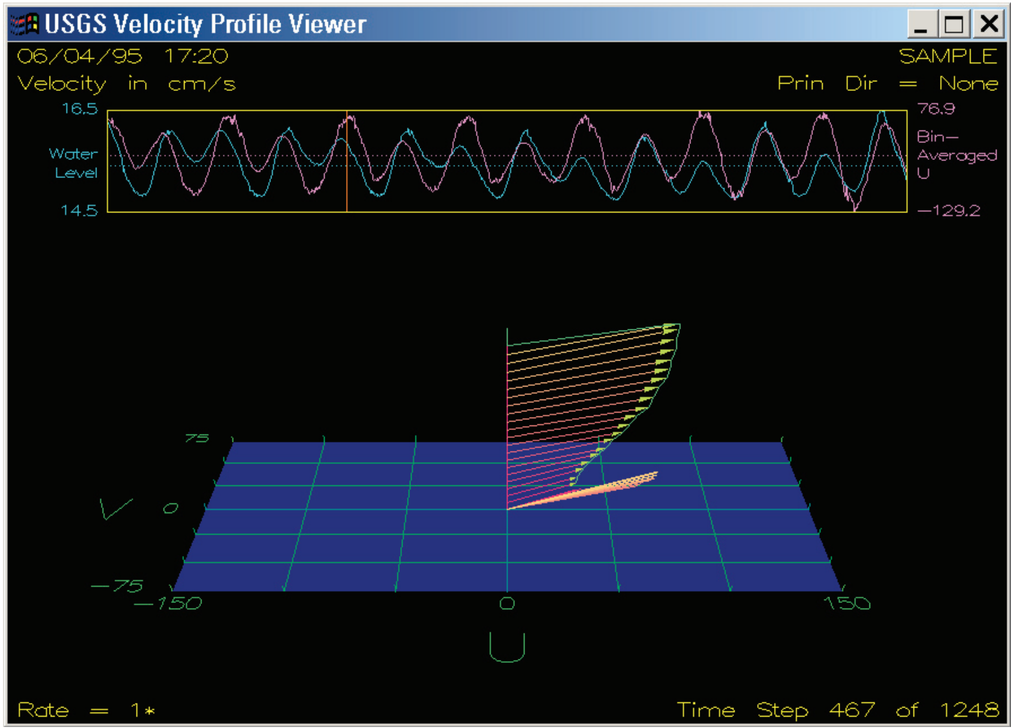


Figure 21. The Velocity Profile Viewer showing the proportions of lines and text when using a medium-sized window and narrow line weight.
The window size is 893 x 640 pixels. The lines are 1 pixel wide for all text and lines.

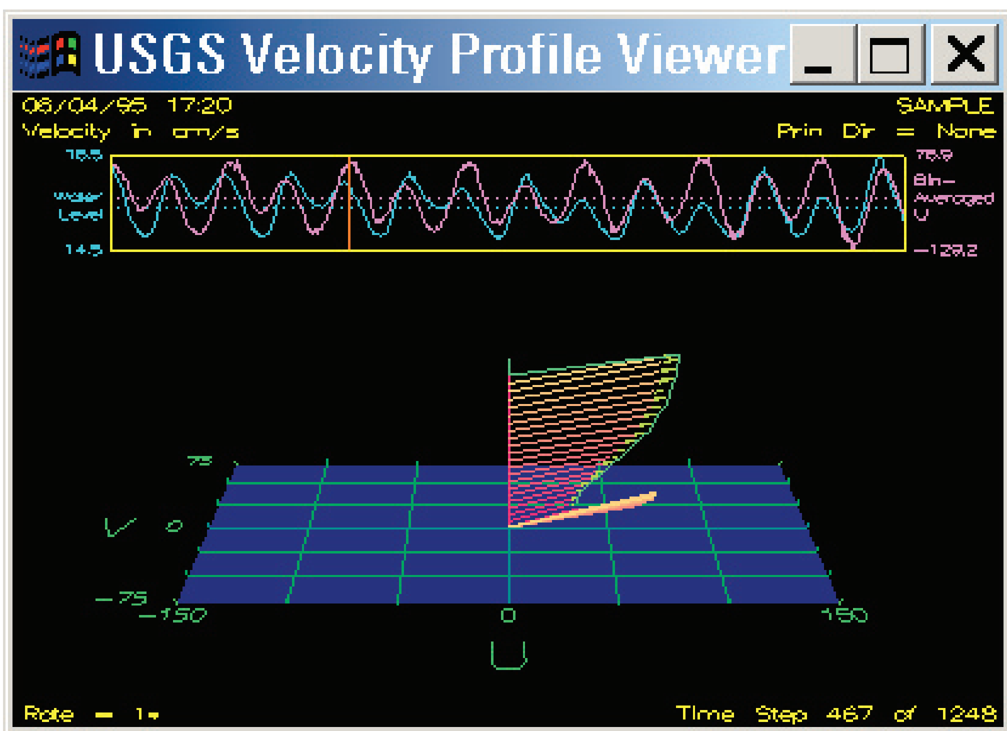


Figure 22. The Velocity Profile Viewer showing the proportions of lines and text when using a small-sized window and narrow line weight.
The window size is 415 x 305 pixels. The lines are 1 pixel wide for all text and lines.

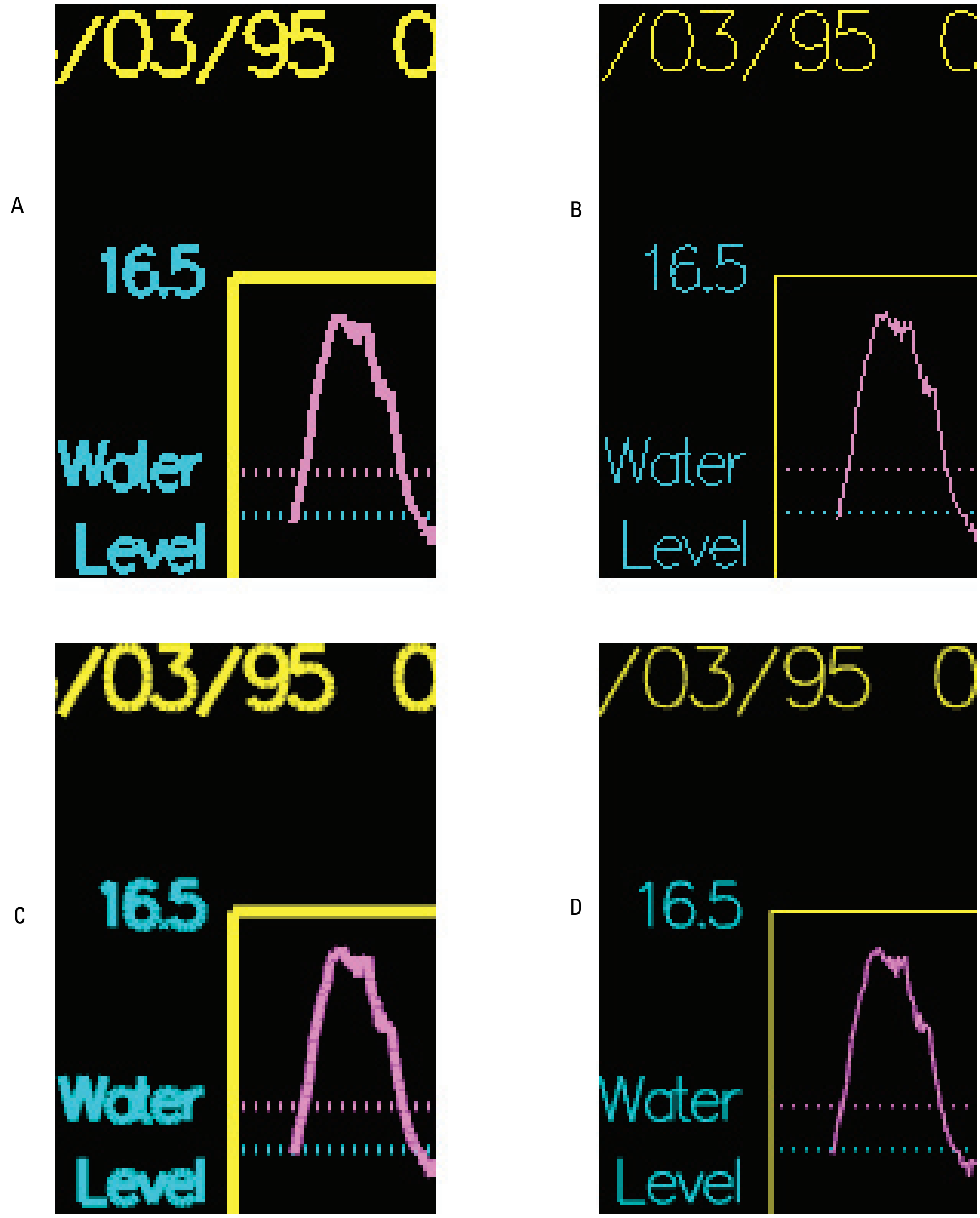


Figure 23. Details of a portion of the Date label and Main Graph in the Velocity Profile Viewer with different line thicknesses and antialiasing settings.
(A) thick lines and text without antialiasing; (B) thin lines and text without anitaliasing; (C) thick lines and text with antialiasing; and (D) thin lines and text with antialiasing.

A

B

C

D

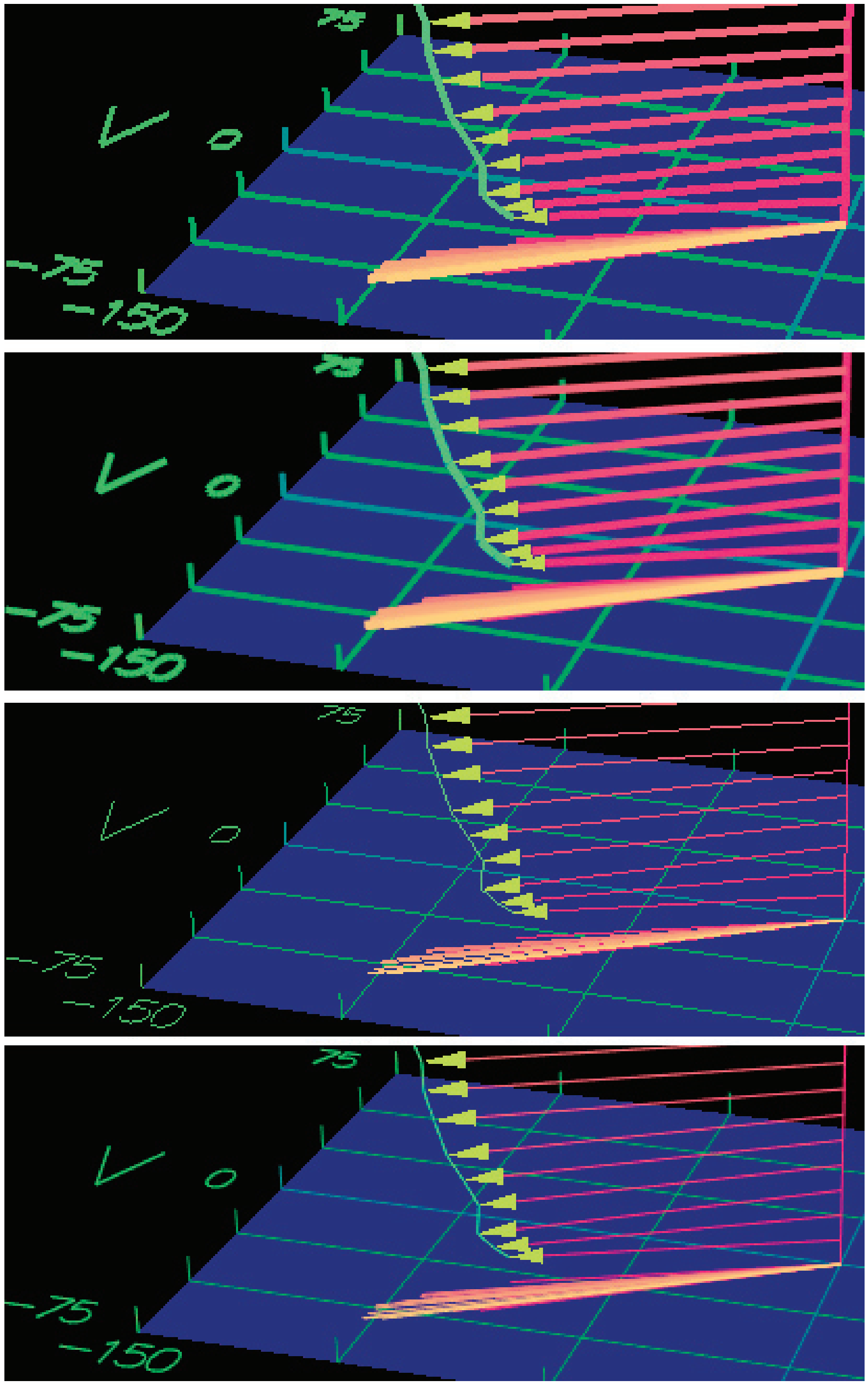


Figure 24. Details of a portion of the three-dimensional velocity profile in the Velocity Profile Viewer including arrows, grid lines, and axis labels with different line thicknesses and antialiasing settings.
(A) thick lines and text without antialiasing; (B) thick lines and text with antialiasing; (C) thin lines and text without antialiasing; and (D) thin lines and text with antialiasing.

Axis Commands

Axis commands change the limits of the U and V axes that are shown at the base of the 3D profile. These commands can be useful when comparing profiles from different files that may have differing default axis scales. As with the bin graphs, the axis limits and grid increments are rounded to the nearest 5, 10, 25, or to one of these numbers multiplied by a power of 10. The axis scaling commands use a multiplier to increase or decrease the axis span. Therefore, the commands sometimes should be repeated to modify the axes limits enough to be bumped to the next grid increment. *Table 4* describes the commands on the Axis menu. *Figure 25* shows the effects of axis movement commands. In each snapshot, the U and V axes span 200 units. The span of each axis is shifted individually between ranges of -125 to 75, -100 to 100, and -75 to 125. The velocity profile remains in the same location within the window while the grid and axes are displaced on eight of the nine combinations shown in *figure 25*. *Figure 26* shows the effects of axis-scaling commands in the 3D profile view. The span of the U and V axes are scaled individually between ranges of -50 to 50, -100 to 100, and -150 to 150. For each of the nine combinations shown in *figure 26*, the velocity profile remains in the same location within the window while the grid and axes change size. When both axes are small, the velocity profile is short with very little spacing between arrows (*fig. 26*A). If at least one axis has a larger span, the height of the profile increases (*fig. 26*B–I).

Table 4. Commands on the Axis menu of the Velocity Profile Viewer.

[These commands affect the base of the three-dimensional profile. See *figures 25-26* for examples]

Command Key	Command Description
6	Decreases the span of the U axis.
7	Increases the span of the U axis.
8	Decreases the span of the V axis.
9	Increases the span of the V axis.
Shift+6	Shifts the span of the U axis lower.
Shift+7	Shifts the span of the U axis higher.
Shift+8	Shifts the span of the V axis lower.
Shift+9	Shifts the span of the V axis higher.

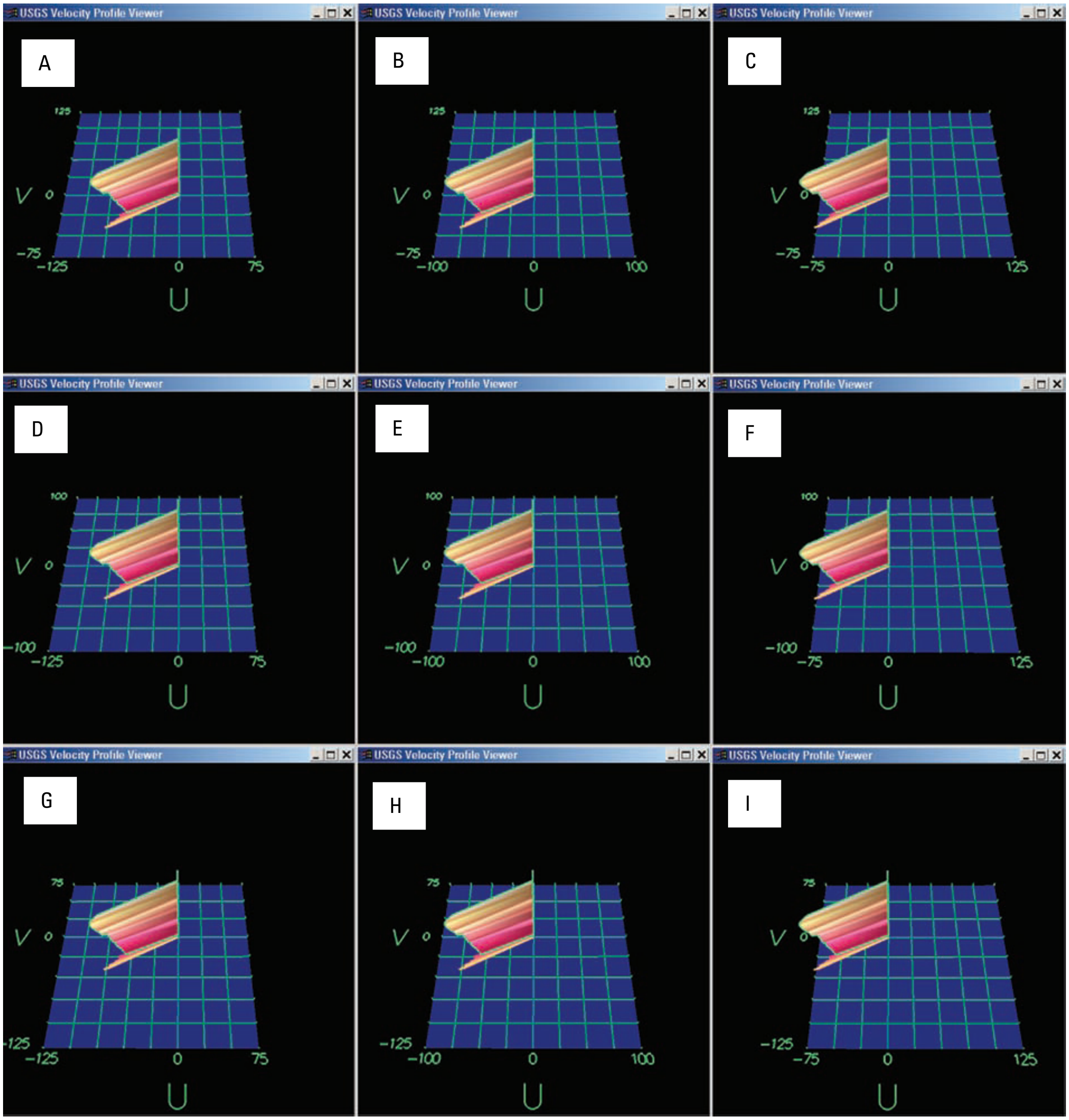


Figure 25. Screen captures showing the effects of shifting the span of the U and V axes in the Three-Dimensional Profile View of the Velocity Profile Viewer.

(F) straight right, (G) down and to the left, (H) straight down, and (I) down and to the right.

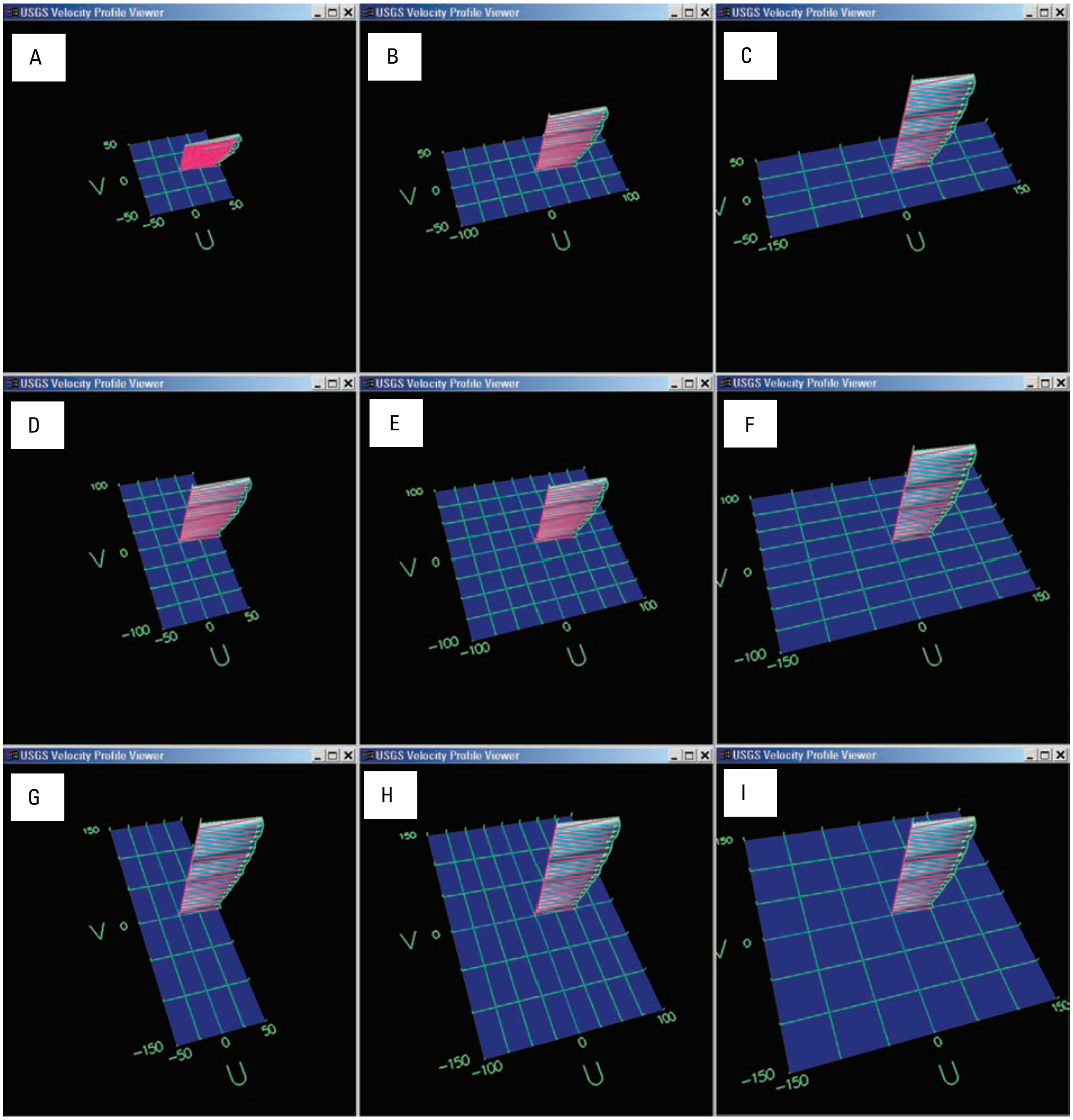


Figure 26. Screen captures showing the effects of axis-scaling commands in the Three-Dimensional Profile View of the Velocity Profile Viewer.
The axis spans, in units, for the U and V axes, respecively, are (A) 100 x 100; (B) 200 x 100; (C) 300 x 100; (D) 100 x 200; (E) 200 x 200; (F) 300 x 200; (G) 100 x 300; (H) 200 x 300; and (I) 300 x 300.

Time-Series Commands

Time-series commands affect the Main Graph near the top of the VPV window (*fig. 27*). A vertical red line shows where the present date and time falls on each graph. By default, the bin-averaged U velocity and water-level curves are overlaid using separate vertical scales. A mean value for each velocity and water level is plotted as a dotted line in the same color as its respective time series. If water-level values are not included in the data file, the water-level curve is omitted. If both time series are disabled, the Main Graph is hidden. Axis labels are shown or hidden with other secondary information (command "2", *table 3*).

The bin-averaged U velocity is the average U velocity component value for all bins with nonzero values. This keeps missing data, which are stored as zeros, from affecting the average. Changing the principal direction causes the U components to change, which will be reflected in the Bin-Averaged U plot.

By default, gaps in the data time series are made more obvious by displaying gap indicators, which are blue vertical lines shown at the beginning and end of each gap in the Bin-Averaged U plot (*fig. 28*). When the beginning and end of a data gap are visible in a graph, a blue line connects the last point before the gap to the first point after the gap. *Table 5* describes the commands on the Time Series menu that are to be used with the Bin-Averaged U plot in the Main Graph.

Table 5. Commands on the Time Series menu of the Velocity Profile Viewer.

[See *figures 27-28* for examples]

Command Key	Command Description
Q	Shows Bin-Averaged U in the Main Graph above the profile.
W	Shows Water Level in the Main Graph above the profile, if the data were given in the input file.
[(left square bracket)	Shows a shorter, more detailed span of the time series.
] (right square bracket)	Shows a longer span of the series.
Shift-G	Shows vertical lines to indicate periods of missing data.

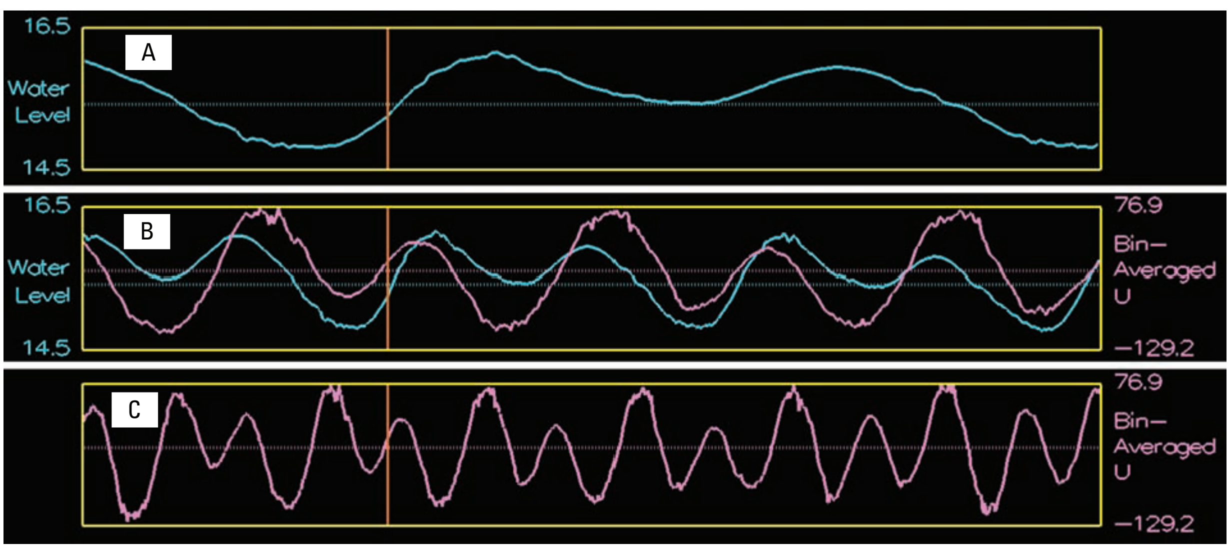


Figure 27. The Main Graph of the Velocity Profile Viewer showing variations in plots of water level and bin-averaged U velocity.
(A) only water level with a short time span showing a high level of detail; (B) water level and bin-averaged U velocity with a medium time span showing a medium level of detail; and (C), only bin-averaged U velocity with a long time span showing a low level of detail.

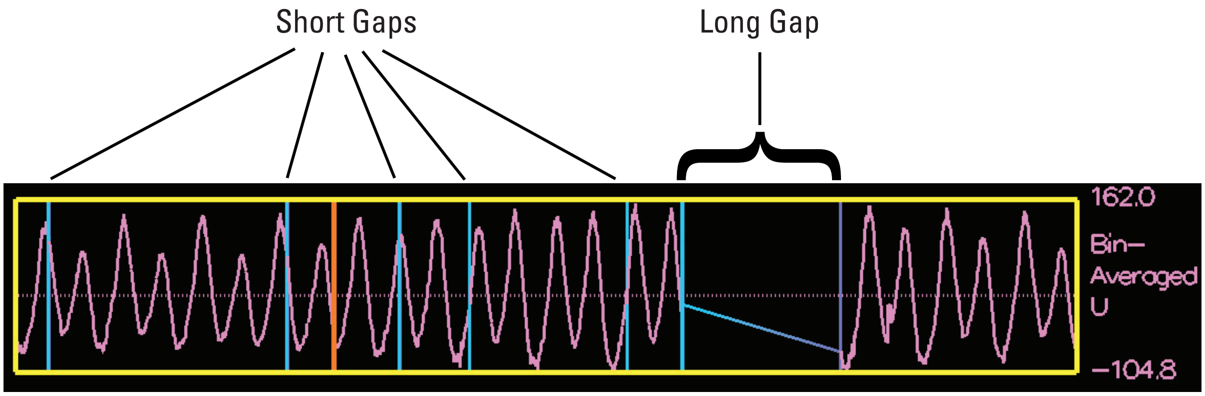


Figure 28. The Main Graph of the Velocity Profile Viewer showing markers for short and long gaps in a data series. Short gaps appear as light blue vertical lines. The colors of the marker lines fade from light blue at the start of a long gap to medium blue at the end.

Orientation Commands

VPV is capable of viewing a profile from any orientation by using the mouse to rotate the entire grid. But with respect to the grid, it also is possible to reorient the profile so that the primary flow direction is along the U axis. This reorientation is done by redefining the principal direction.

The principal direction represents the primary direction of positive flow and is measured clockwise from the top of the grid. By default, the principal direction is 90 degrees, which causes the U axis to represent east velocity and the V axis to represent north velocity, assuming the first column in the input file is the east component and the second column is the north component. For a channel with a positive U component that flows east, the default grid allows the user to view the profile from the south bank looking north across the channel.

Table 6 describes the commands on the Orientation menu. If the principal direction of the profile is known, the user can rotate the axes and view the profile perpendicularly to that direction. The Bin-Averaged U plot also will be recalculated and the grid will be resized to accommodate the new shape of the plot.

If the user doesn’t know the principal direction angle, it can be estimated by using the commands “<“ and “>”. Using one of these keys will overlay white axes on the profile base as a preview of how the new axes would line up with the velocity profile. The user should continue to rotate the axes until they are aligned with the velocity profile. Once editing of the angle begins, the principal direction label shows the actual default of “90.0” rather than “None.” *Figures 29–31* show a velocity profile before, during, and after a realignment of the principal direction, respectively.

Table 6. Commands on the Orientation menu of the Velocity Profile Viewer.

[See *figures 29-32* for examples]

Command Key	Command Description
. (period)	Increases the principal direction indicators by 5.0 degrees.
>	Increases the principal direction indicators by 0.1 degree.
, (comma)	Decreases the principal direction indicators by 5.0 degrees.
<	Decreases the principal direction indicators by 0.1 degree.
Shift-P	Recalculates the U and V components of the velocity profile bins using the newly chosen principal direction.
P	Switches between viewing the profile in the principal direction and viewing it in its original orientation.

While setting the principal direction, a preview of the new angle overlays the profile base as a multi-colored, pie-shaped portion of a unit circle that increases from a sliver when the angle is near 0 degrees up to a full circle when the angle is near 360 degrees. The angle is clamped to the range -360 to 360 degrees. *Figure 32* shows a detail of the graphic representation of the angle being selected as the new principal direction.

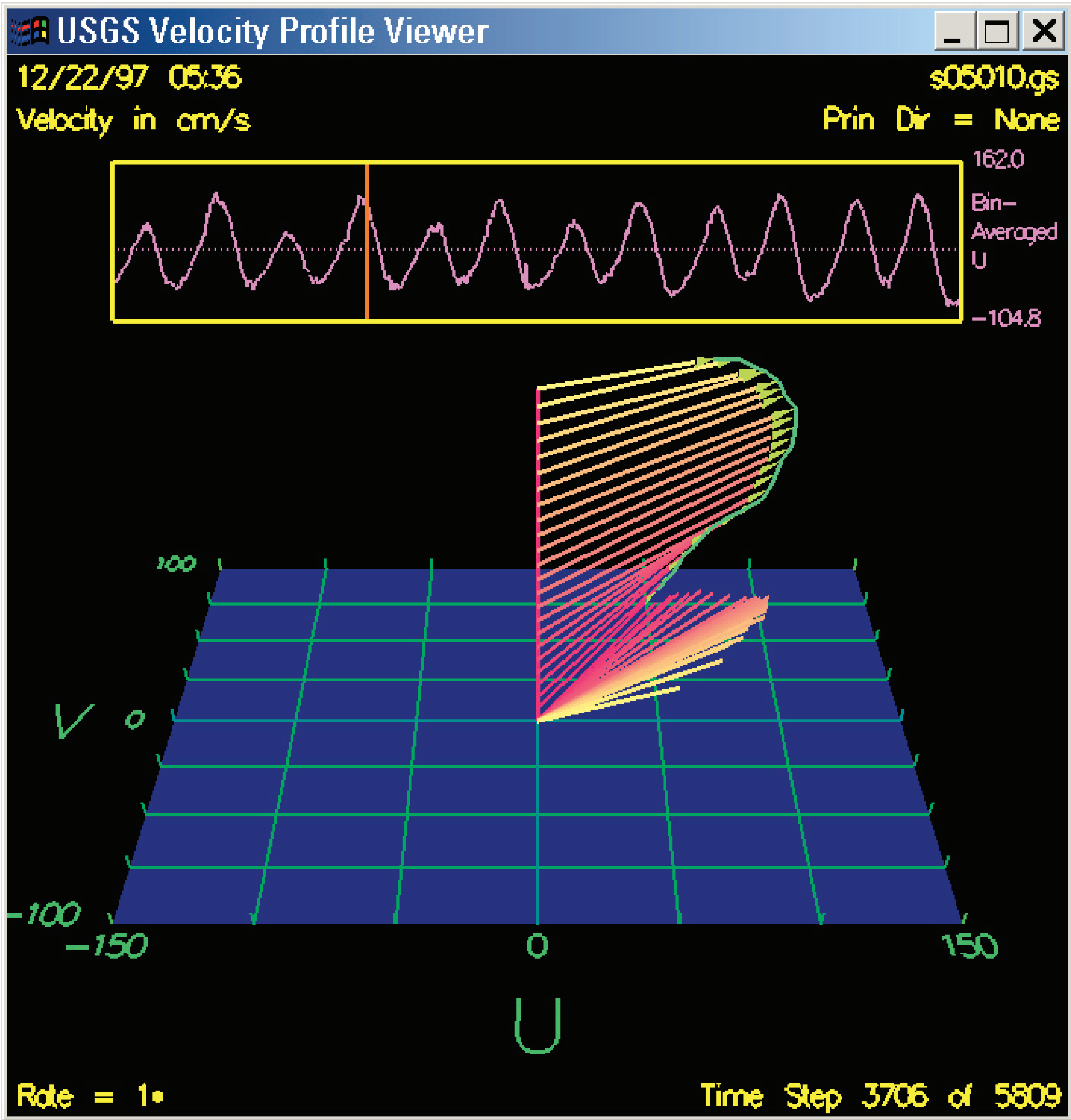


Figure 29. The Velocity Profile Viewer before a realignment of the profile's principal direction with the U axis. The principal direction label shows the default value of "None."

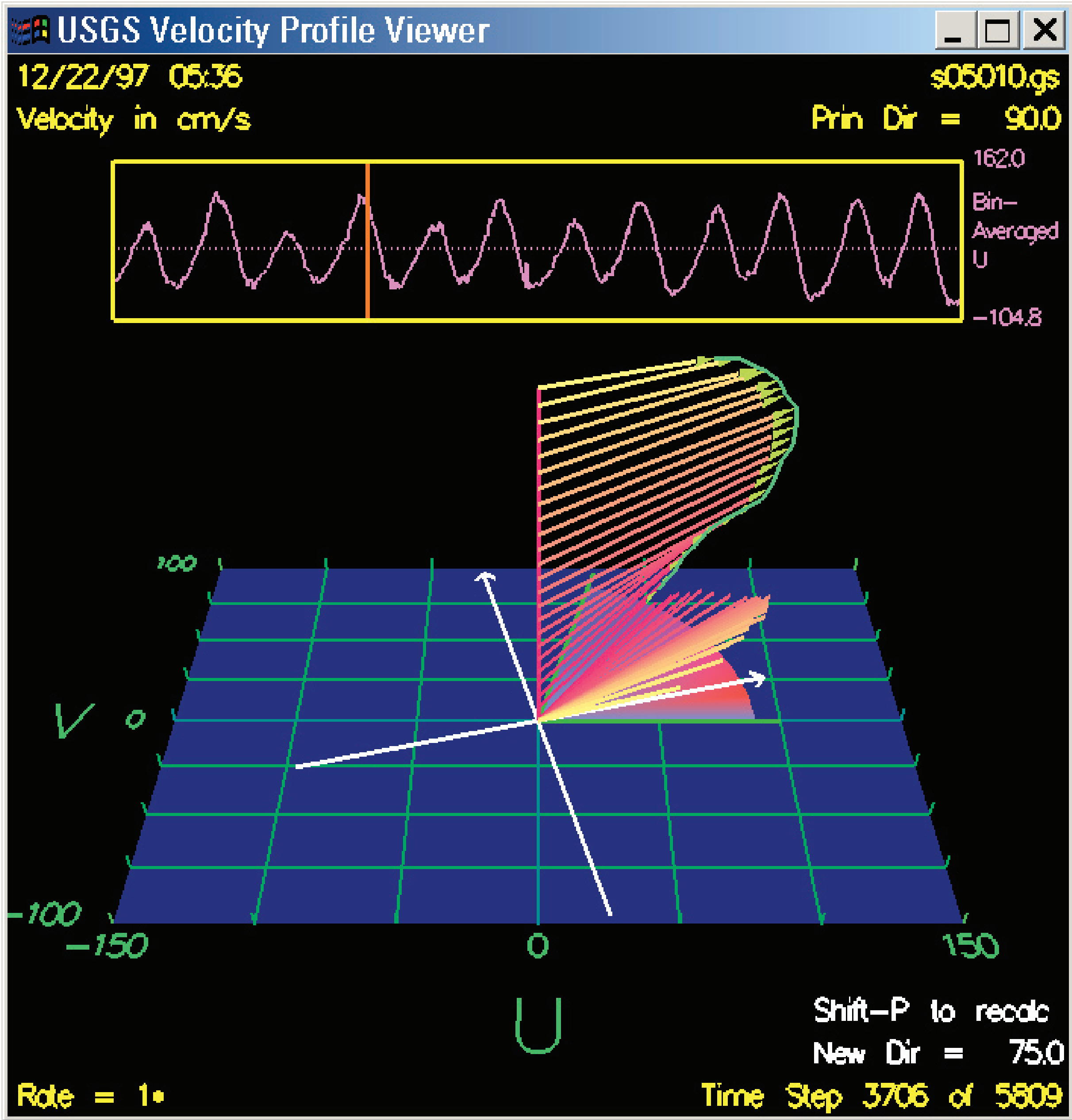


Figure 30. The Velocity Profile Viewer during a realignment of the profile's principal direction with the U axis. The new alignment of the axes and the graphic representation of the new angle are superimposed on the grid. The specified angle is shown in white near the bottom right corner of the window. The principal direciton label shows "90.0."

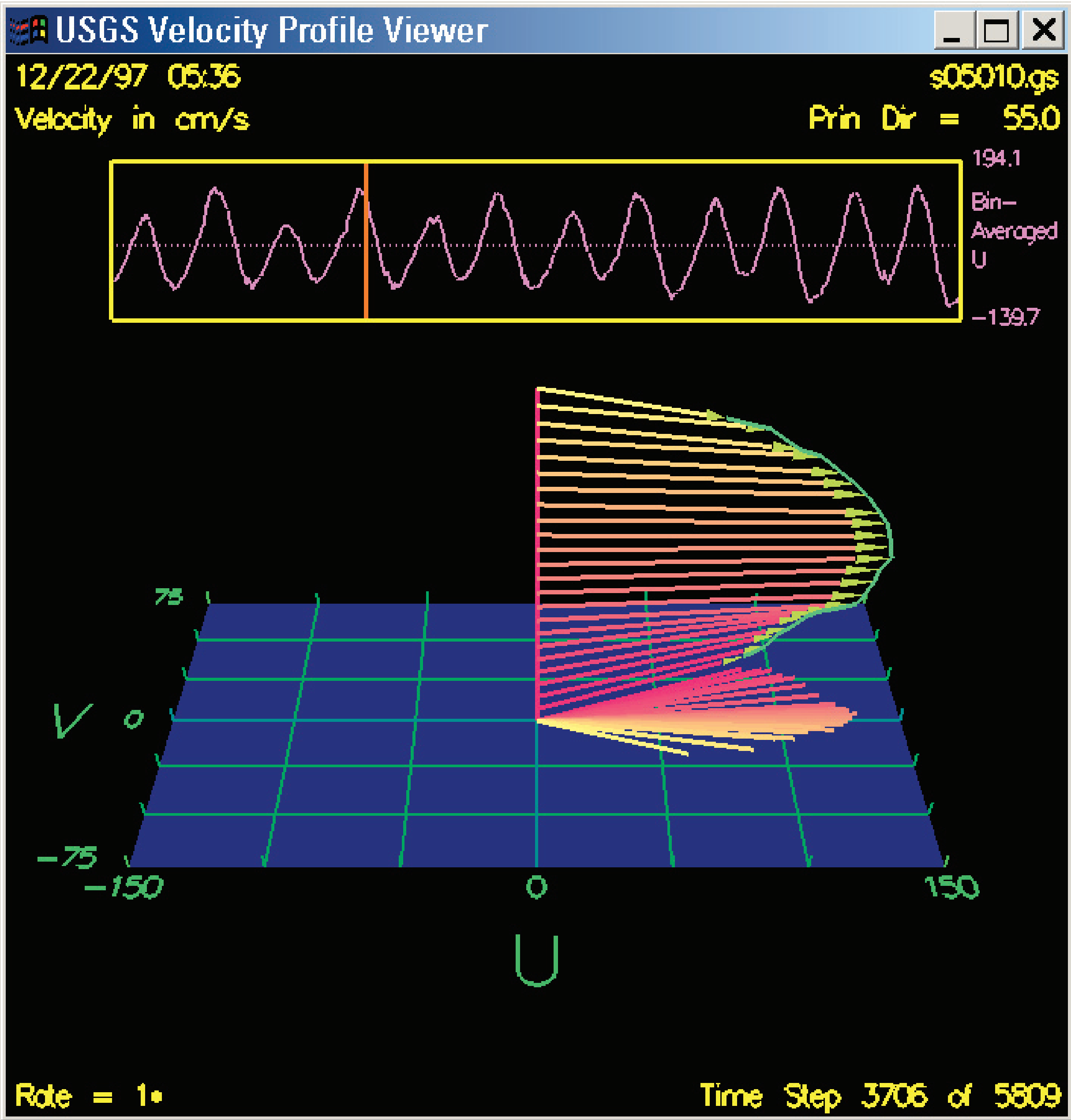


Figure 31. The Velocity Profile Viewer after a realignment of the profile's principal direction with the U axis. The principal direction label has changed to "55.0." The grid and axis limits are rescaled to fit the new U and V bounds of the profile.

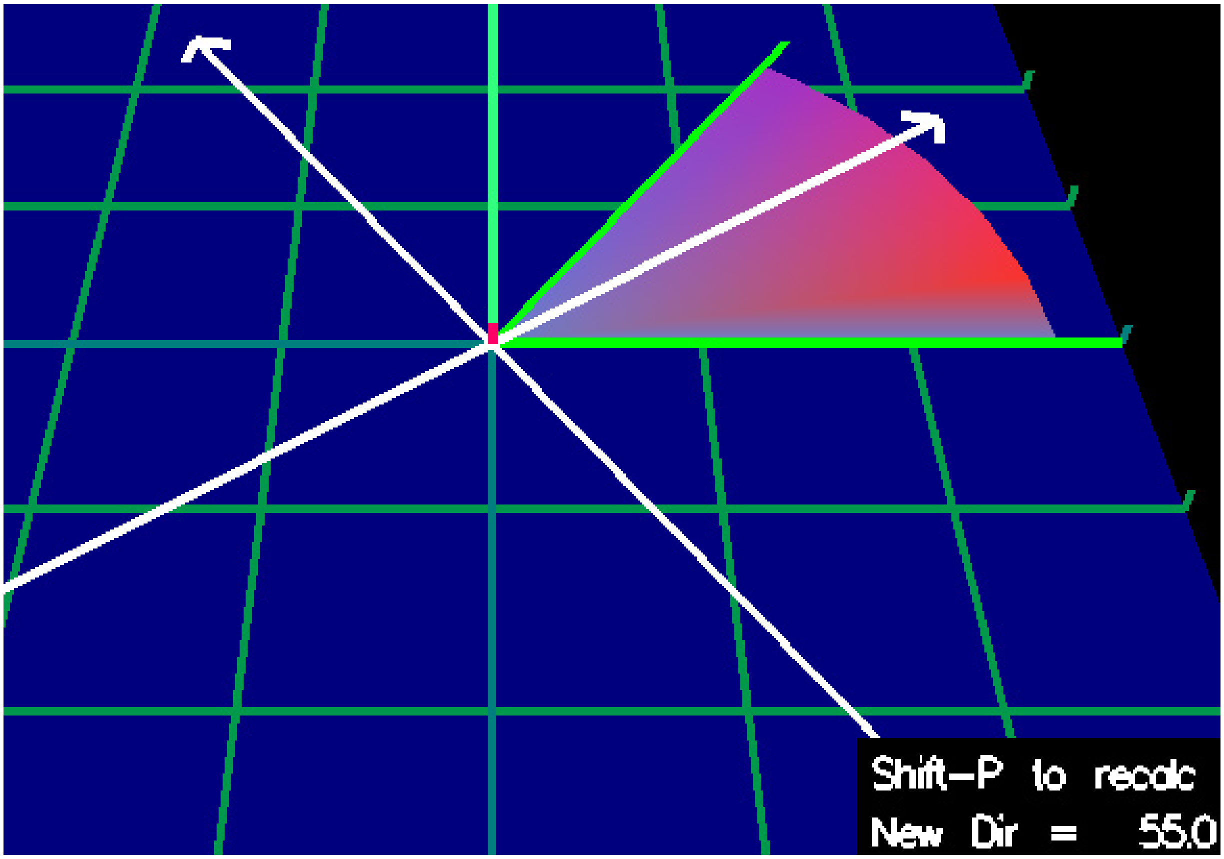


Figure 32. A detail of the graphic representation of the angle being selected as the new principal direction. The two white arrows represent how the U and V axes would line up below the profile.

Animation Commands

Animation commands affect how the time series "plays". The frame rate can be increased, decreased, stopped, or reversed. There are several frame rates between 0 and 1 that let the file play forward more slowly if the speed of the computer causes the frame rate to be too high. *Table 7* describes the commands on the Animation menu.

The "Y" command changes the way frame rates between 0 and 1 are shown. The default is to interpolate from one time step to the next. This looks smooth, but the majority of frames shown are fictitious, (for example, 49 interpolations and 1 actual). The other method repeatedly shows the same frame and then moves to the next (50 actual, 50 actual, and so on). The latter method is sometimes desirable if the user wants to view only actual data from the file. *Figure 33* shows how the Time Step Increment label displays various increments. Usually, the time step advances too quickly to read the number of each interpolated time step, but the user can see it advancing. The interpolated time step is shown as a reminder that the frames are interpolated.

Table 7. Commands on the Animation menu of the Velocity Profile Viewer.

[See *figure 33* for example]

Command Key	Command Description
N	Stops animation on the most recently shown time step. Acts as a toggle to start animation if stopped.
+ (plus) or = (equal)	Increases the frame rate.
- (minus)	Decreases the frame rate.
Y	Interpolates between time steps when the increment is between zero and one. Acts as a toggle to draw only exact time steps if interpolation is on.

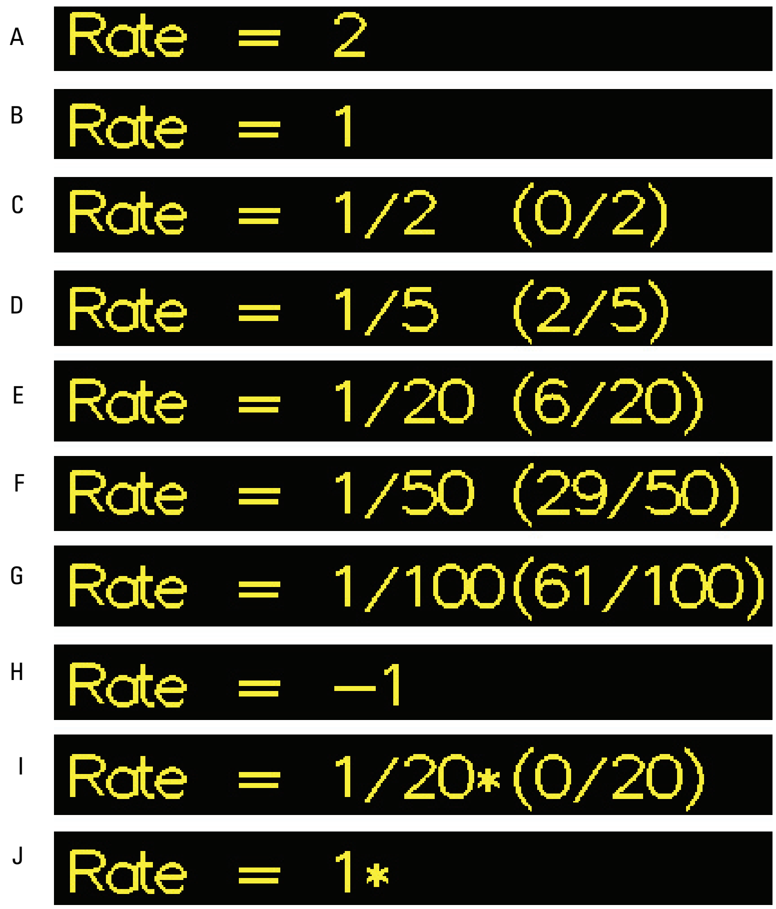


Figure 33. Screen captures of the Time Step Increment label at various rates. (B) through (H) show the rate that results from giving the "-" command for the previous rate.

*Figure 33*A shows a rate of 2. *Figures 33*B–H show the rate that results from decreasing the rate above it. *Figures 33*C–G are fractional forward rates, with 1/100 being the slowest. The fractional rates tell which interpolated frame currently is being shown. For example, in *figure 33*F, the rate is 1/50 and the displayed profile is the 29th of 50 interpolations between the displayed time step and the next time step. *Figure 33*H is a negative rate that causes the animation to play backwards. In *figures 33*I–J, the asterisk indicates that the viewer is stopped on one time step. *Figure 33*I shows a fractional rate of 1/20, so when it is stopped, it shows the interpolation progress toward the next frame as 0 of 20 frames.

Bin Graphs Commands

Bin Graphs commands affect the profile when it is shown as four time-series graphs in place of the 3D profile. The "[" and "]" keyboard commands (*table 5*) show either a shorter or longer span of the time series, respectively. Most Orientation, Animation, and Jump commands also work with the bin graphs. See the Zoom Commands and View Commands sections of this report for explanations of using the I, Shift+I, O, and Shift+O commands (*table 2*) or the R and C commands (*table 3*) in the Bin Graph View.

Table 8 describes the commands on the Bin Graphs menu. *Figures 34–38* show different displays for the Bin Graph View. The Main Graph is at the top of the window showing bin-averaged U velocity, except in *figure 35* where it was turned off using the "Q" and "W" commands (*table 5*). The date, time, and location labels are shown at the top of the window in each figure, except *figure 34* where they were turned off using the "1" command (*table 3*). Principal direction and time step labels are hidden in *figures 34–38*, except in *figure 35,* where they were turned on using the "2" and "3" commands (*table 3*). The axis labels and titles are shown beside each graph in *figures 34–38*, except in *figure 36* where they were turned off using the "4" command (*table 3*). The "C" command is used to show the colored backgrounds in *figures 35–38*.

Table 8. Commands on the Bin Graphs menu of the Velocity Profile Viewer.

[See *figures 34-38* for examples]

Command Key	Command Description
M	Toggles between the three-dimensional Profile View and the Bin Graph View.
K	In Bin Graph View, toggles between showing U and V component curves and angled sticks.
Z	Shows the previous bin in the graph beneath the cursor. If the lowest-number bin is showing, it cycles to the highest-number bin.
X	Shows the following bin in the graph beneath the cursor. If the highest-number bin is showing, it cycles to the lowest-number bin.

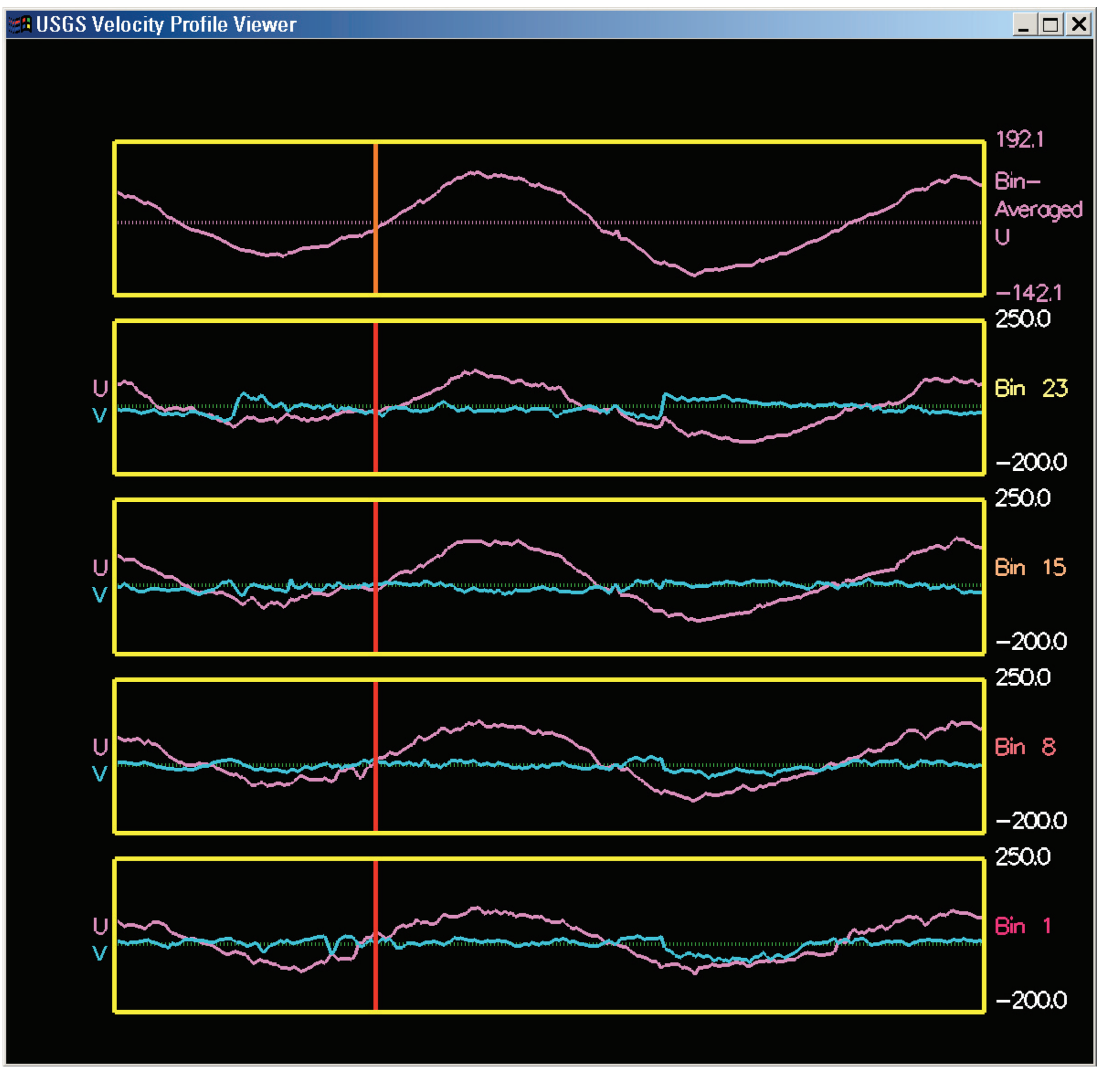


Figure 34. The Bin Graph View of the Velocity Profile Viewer showing U and V component graphs on a black background with no lines of text displayed.
Graphs for bins 1, 8, 15, and 23 are shown below the Main Graph. The time span is shortened to show less than one tidal cycle to see more detail on the curves.

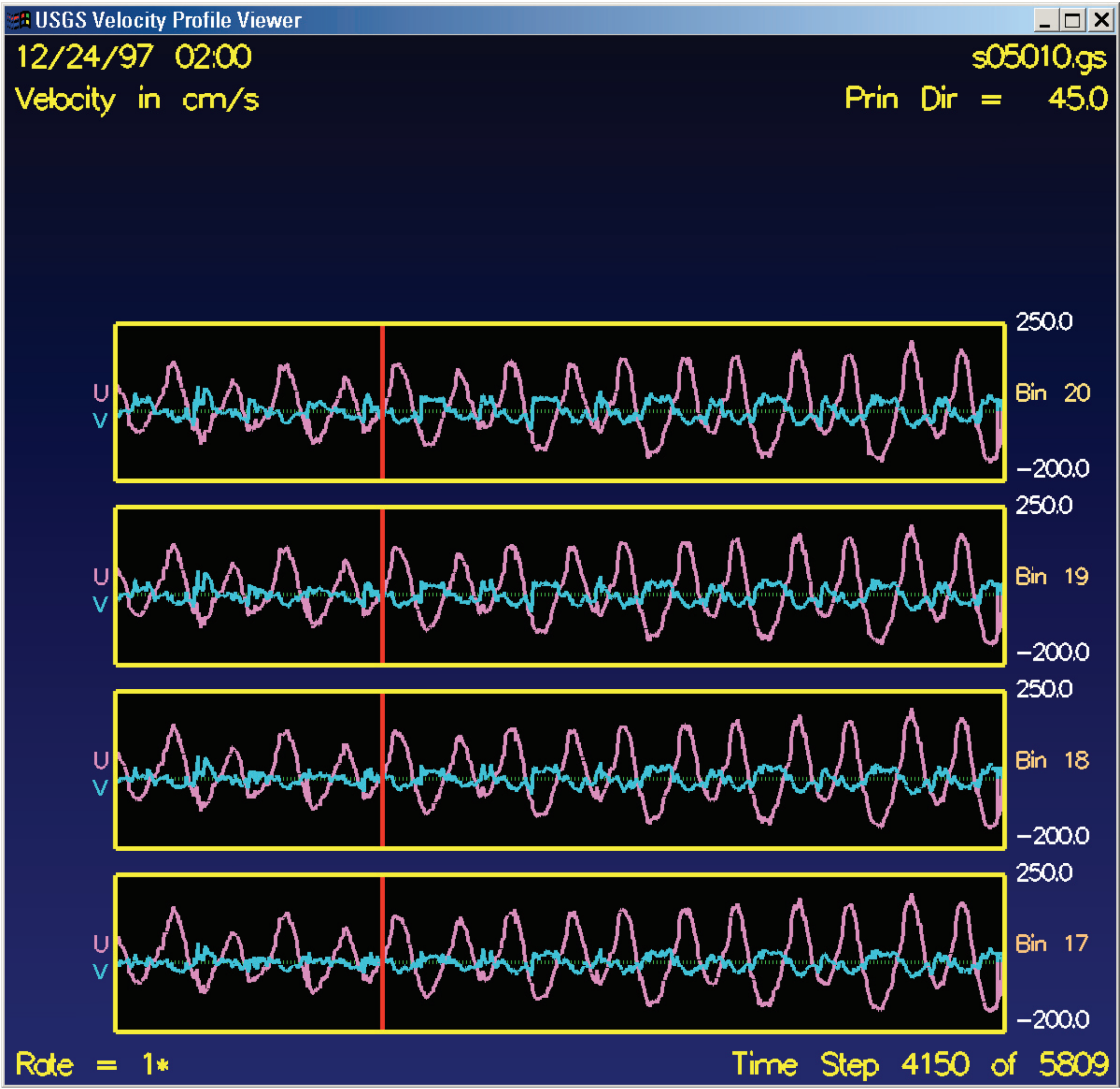


Figure 35. The Bin Graph View of the Velocity Profile Viewer showing U and V component graphs on a blue background with all lines of text displayed in yellow.
The Main Graph is hidden (using the "Q" and "W" commands), but graphs for bins 17-20 are shown. The time span shows about 8 tidal cycles.

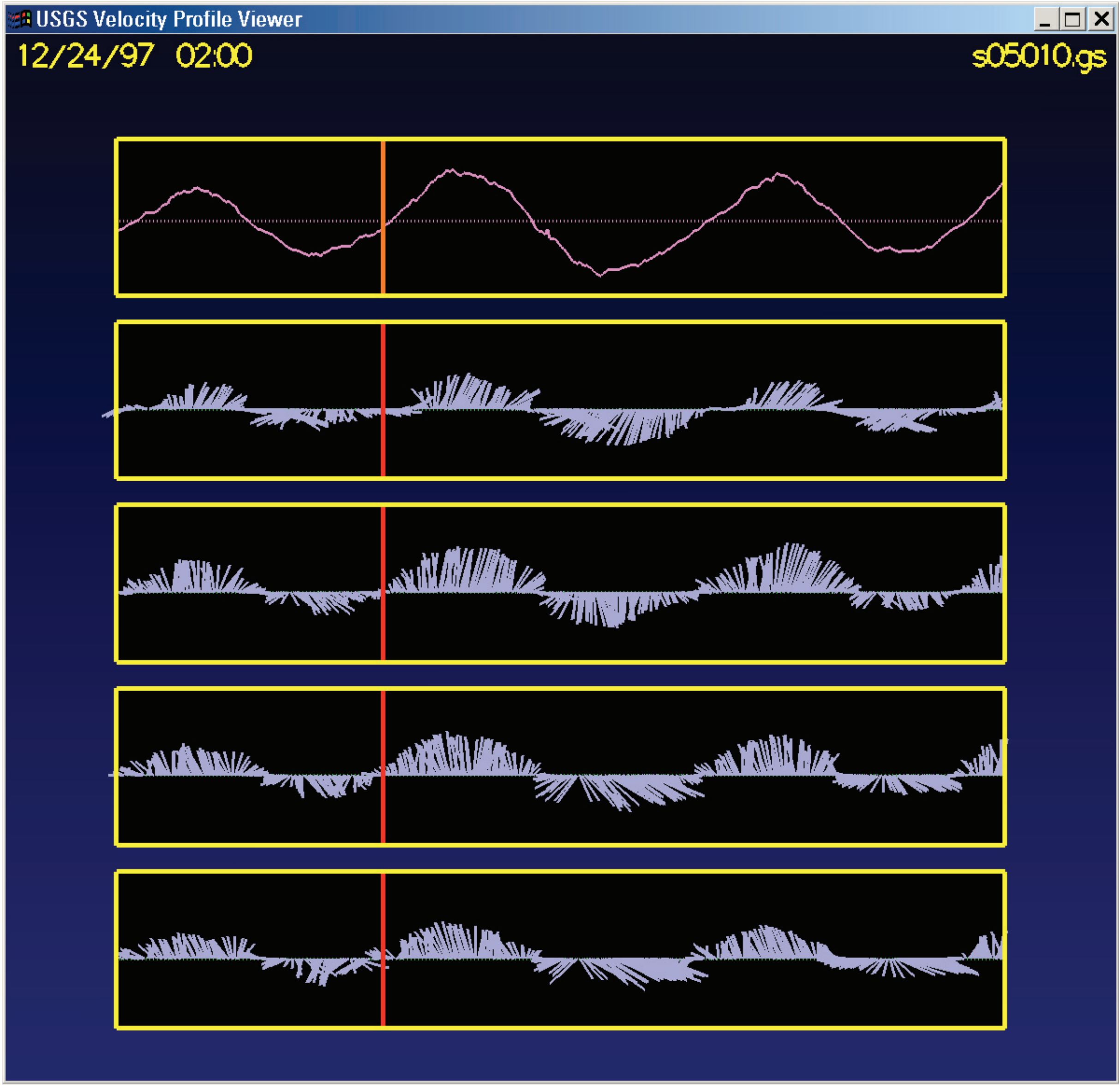


Figure 36. The Bin Graph View of the Velocity Profile Viewer showing tidal velocity stick plots on a blue background. Graphs for bins 17-20 are shown below the Main Graph. The time span shows about 1.5 tidal cycles.

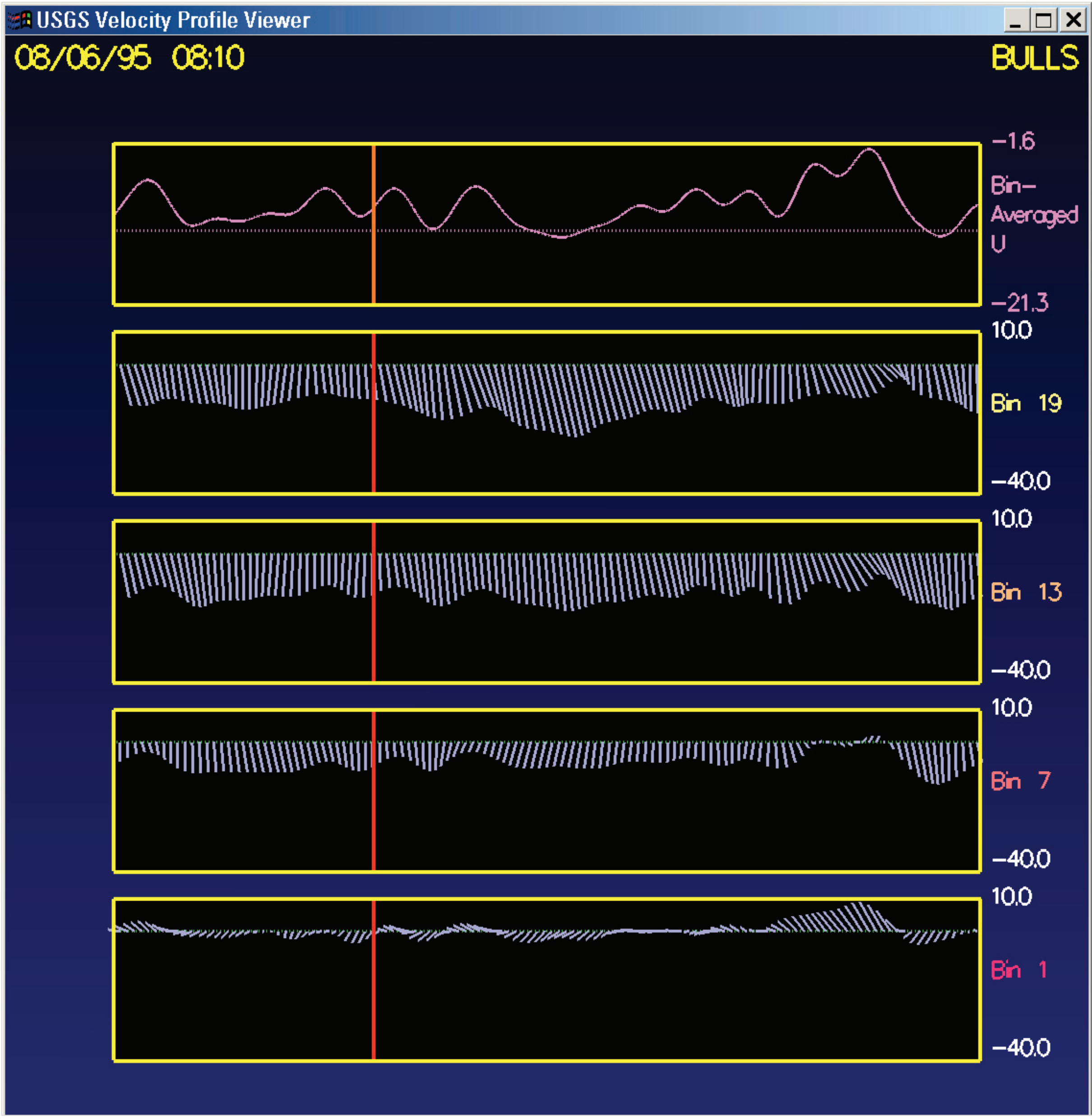


Figure 37. The Bin Graph View of the Velocity Profile Viewer showing tidally filtered velocity stick plots on a blue background.
Graphs for bins 1, 7, 13, and 19 are shown below the Main Graph.

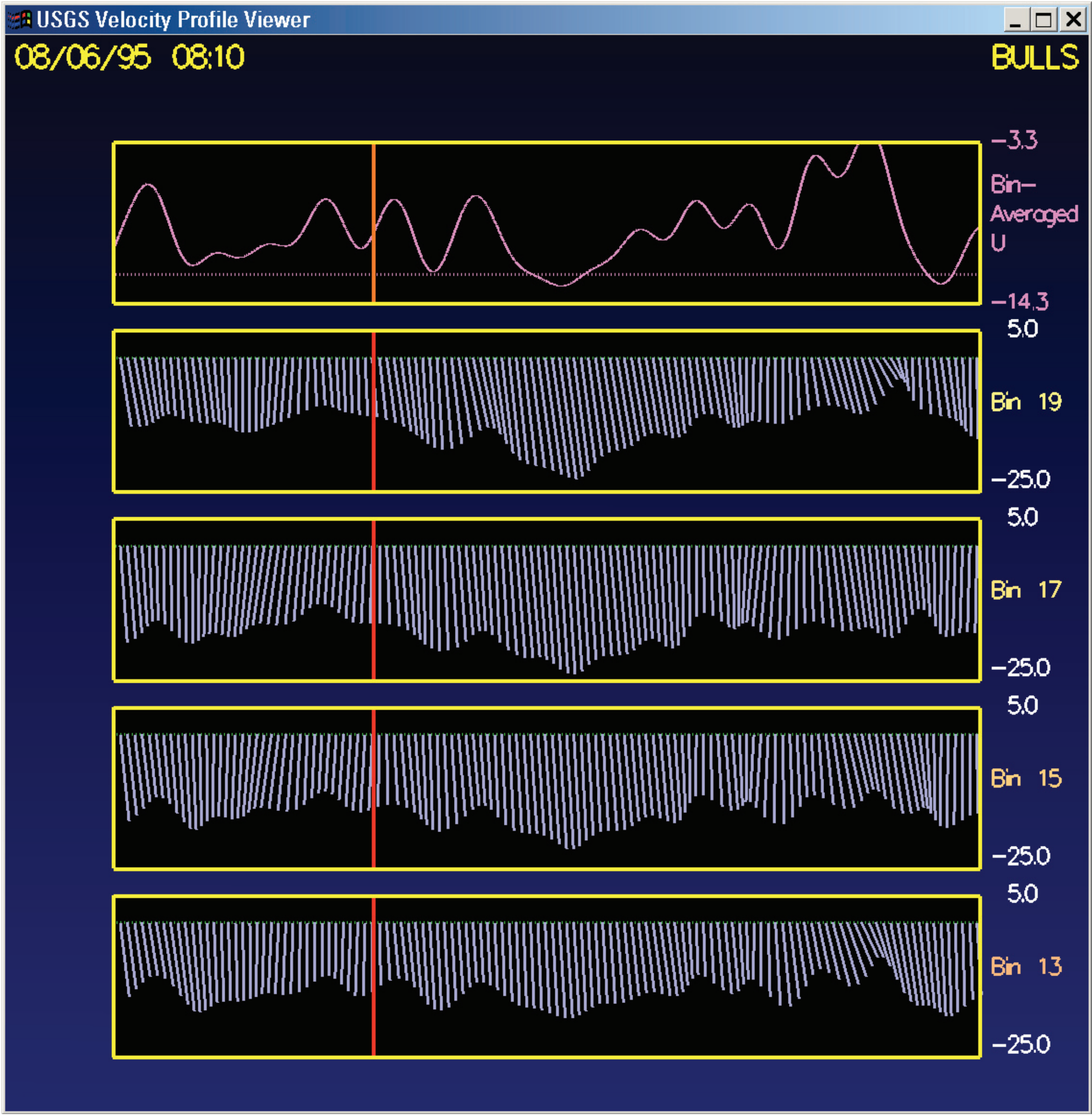


Figure 38. The Bin Graph View of the Velocity Profile Viewer showing vertically shifted and rescaled stick plots. This shows the same time span and data as shown in *Figure 37* of this report, except that the bins showing are 13, 15, 17, and 19. The stick plot axis spans all have been decreased and shifted from between -40 and 10 in *Figure 41* to between -25 and 5 in this figure. The Main Graph Y axis also is affected.

Help Commands

Help commands display information about VPV and using the mouse. The graphics libraries that VPV uses make it difficult to implement a sophisticated help system with popup windows, so the Help screen was added as a convenience to make basic information available to the user at run time without having to refer to the manual. By using these commands and the popup menu, users who are familiar with the application should be able to refresh their memories on the mouse controls. However, the VPV manual should be consulted for detailed instruction.

If antialiasing is turned on, the help screen will have a slightly different appearance. *Table 9* describes the commands on the Help menu. *Figure 39* shows help, version, and author information within the VPV window.

Table 9. Commands on the Help menu of the Velocity Profile Viewer.

[See *figure 39* for example]

Command Key	Command Description
Shift-M	Displays a short description of what clicking and dragging the mouse does when various meta keys are held down. Covers the center area of the window where the three-dimensional profile would be drawn.
V	Displays version and author information along the bottom of the window and a small Velocity Profile Viewer logo near the top of the window.

Main Menu Commands

There are two commands at the bottom of the main menu, below the submenus (*table 10*). See the Printing section of this report for further information regarding the Shift+S command.

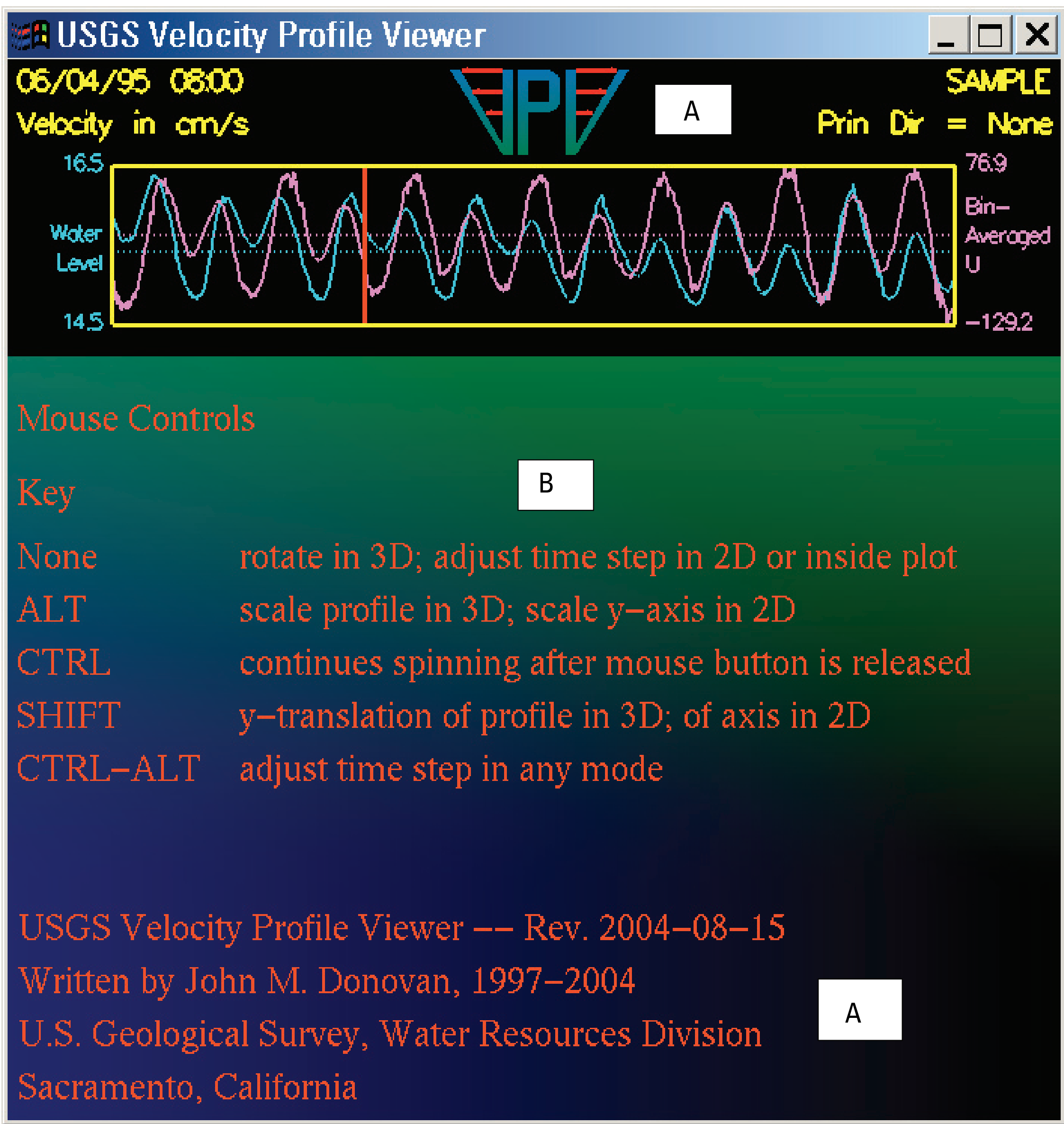


Figure 39. The Velocity Profile Viewer after giving the "Mouse Help" and "About VPV" commands. The "About VPV" command shows (A) the VPV logo at the top and four lines of text at the bottom. The text includes the name of the program, date of the last revision, author, and agency information. The "Mouse Help" command covers the center area (B) with lines of text.

Table 10. Commands on the Main menu of the Velocity Profile Viewer.

[See *figures 40-42* for examples]

Command Key	Command Description
Shift-S	Saves a four-view representation of the current time step to a PostScript file.
Escape	Exits the program, closing the Velocity Profile Viewer window immediately.

Printing

VPV has the capability of creating printable output. The Shift+S command (*table 10*) creates a printable PostScript file in the same directory as the input file, with care taken not to overwrite any existing file. The first file name it tries is “vpv01.ps”. If that file exists, it tries “vpv02.ps” and so on until it finds an unused filename. If “vpv01.ps” through “vpv99.ps” all exist, then the output overwrites the file “vpv.ps”.

The file can be printed on a PostScript printer or viewed and printed on any printer using a PostScript viewer application such as Ghostview or GSview, which are available at *http://www.cs.wisc.edu/~ghost/*. The file also can be imported into an illustration package such as Adobe Illustrator or Corel Draw, and manipulated as vector graphics.

The output is an 8.5 x 11-inch print, separated into four different views of a profile (*fig. 40*). The primary and secondary information from the screen is shown above the quadrants. The top right view (*fig. 40*B) is a perspective of the profile matching the image on the screen. The other three views make up a standard three-view, orthographic projection of the top (U-V) (*fig. 40*A), side (U-Z) (*fig. 40*C), and front (V-Z) (*fig. 40*D) of the profile.

The output matches the screen as closely as possible. Some colors are modified so they will be visible on white paper. The perspective view uses the same rotation and zoom as is on the screen. It closely matches the image on the screen in the area below the Main Graph, but does not include the axis labels. The perspective view always shows a projection on the base, even if “Color by depth” is not selected. The same output is created, regardless of whether the 3D Profile View or Bin Graphs View is being shown on the screen while the command is given.

When “Color by depth” is selected, the PostScript output is color (*fig. 41*), and when it is deselected, the output is black and white (*fig. 40*). The View commands that affect the output file are “S”, “A”, “C”, “1”, “2”, “4”, “G”, and “J” (*table 3*, *fig. 42*).

The Axis commands can be used to change the axis limits. The orthographic views will scale the axes to fit each quadrant of the page. Each quadrant has a clipping region outline to keep one view from showing on top of another.

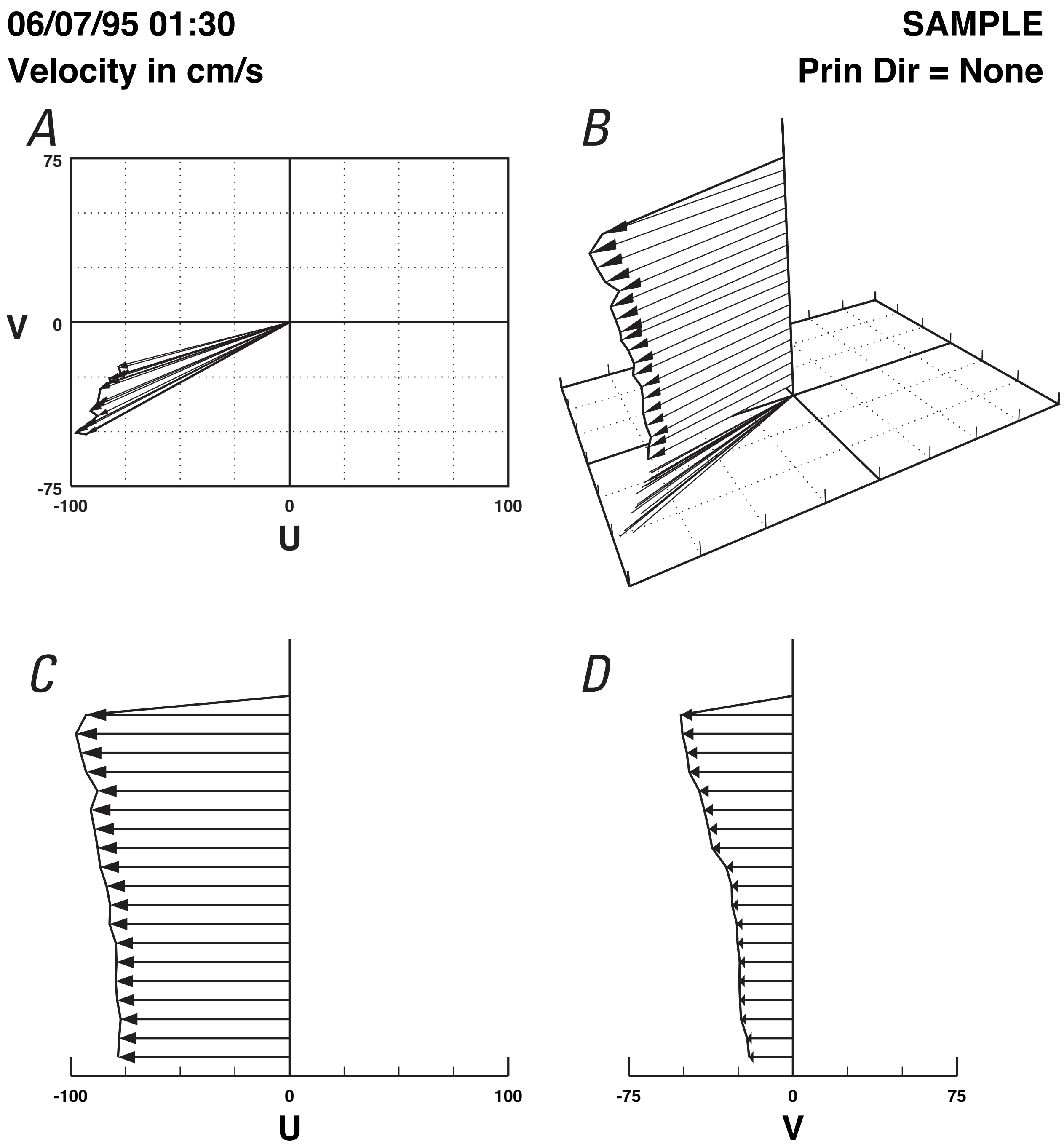


Figure 40. Example showing black and white PostScript output from the Velocity Profile Viewer.
The four views shown are (***A***) top; (***B***) perspective; (***C***) front; and (***D***) side. Arrows, the profile surface, grid lines, axis labels, and two lines of text are shown.

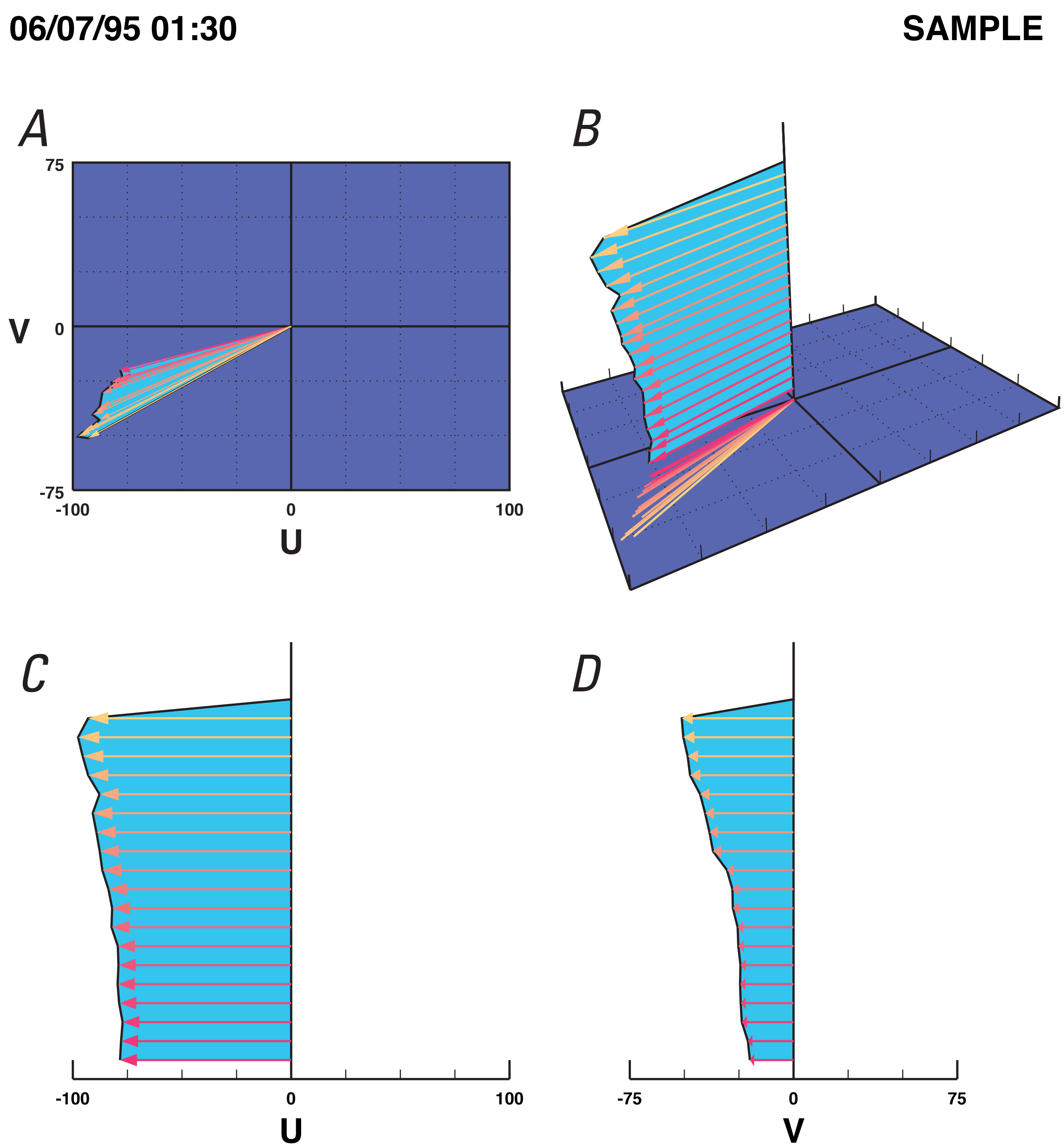


Figure 41. Example showing color PostScript output from the Velocity Profile Viewer showing a profile with arrows, a surface, and grid lines on the base.
The four views shown are (***A***) top; (***B***) perspective; (***C***) front; and (***D***) side. Arrows, the profile surface, grid lines, axis labels, and the date and location text are shown. The units and principal direction text are not shown.

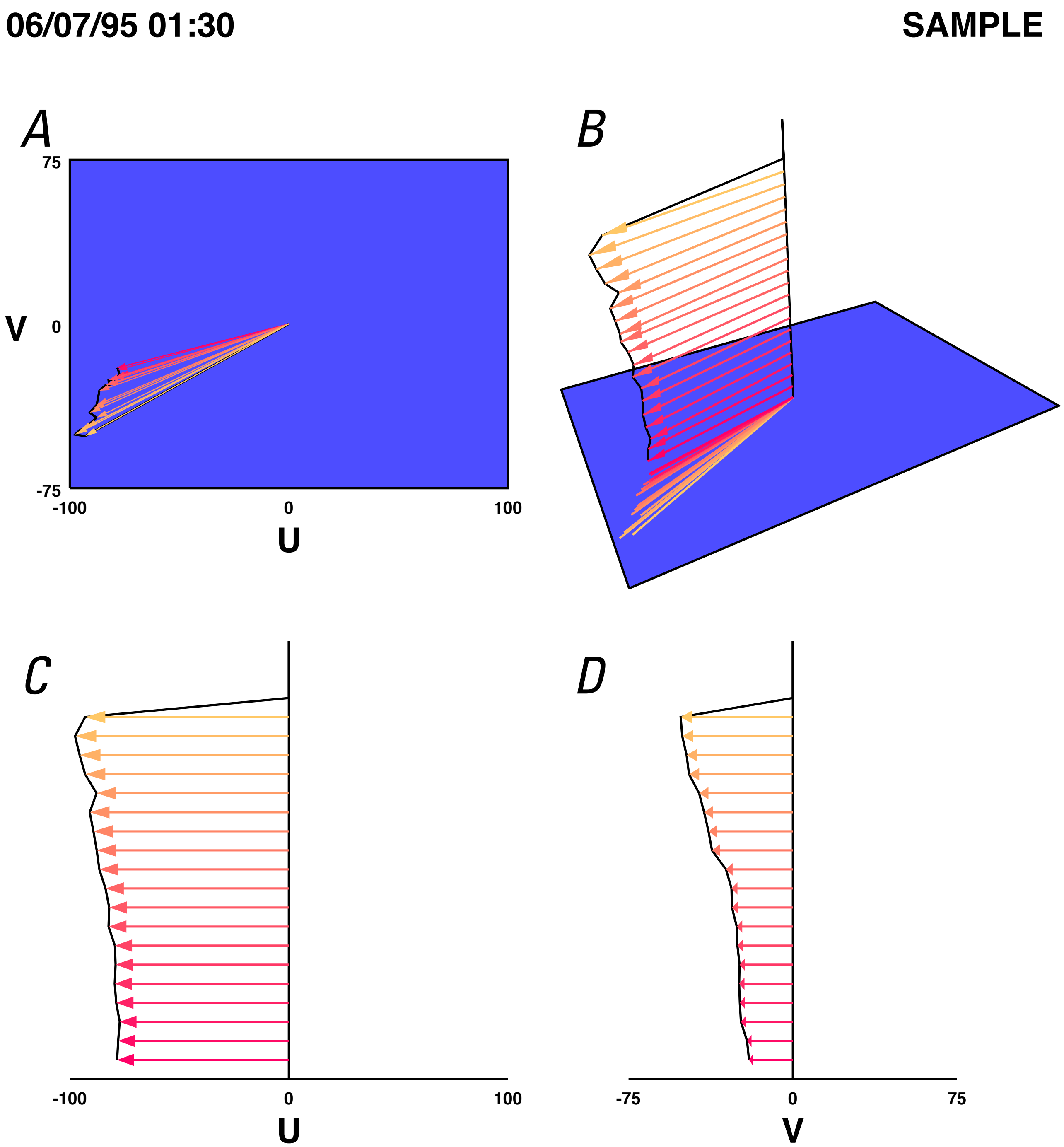


Figure 42. Example showing color PostScript output from the Velocity Profile Viewer showing a “bare” profile. The four views shown are (***A***) top; (***B***) perspective; (***C***) front; and (***D***) side. Arrows, axis labels, and the date and location text are shown. The profile surface, grid lines, and the units and principal direction text are not shown.

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APPENDIXES

Appendix 1: Installing and Running the Velocity Profile Viewer Application

VPV is available on the World Wide Web at *http://ca.water.usgs.gov/program/sfbay/vpv/*. This report describes the version of VPV last modified on August 15, 2004.

VPV is a simple application that consists only of an executable file, although it requires the availability of supporting libraries.

Installing the Application

To install VPV on a personal computer (PC) running Windows, download the vpv.exe and vpv.ico files from the VPV web page to any directory on the PC. A shortcut to the application can be created and placed on the Windows desktop, and the vpv.ico file can be set as the icon for this shortcut (*fig. A1*). Four Dynamic Link Library (DLL) files also are required: msvcrt.dll, opengl32.dll, glu32.dll, and glut32.dll. These files are available on the VPV website. The files should be included with post-1997 versions of Windows with the exception of glut32.dll, which usually does not come with Windows. If any of the four required DLL files are not in the Windows path, VPV will show an error at run time. Download any missing DLL files from the VPV web page and place them in the Windows System directory, or in the same directory as the VPV executable file.

To install VPV on an SGI, the machine must be running under IRIX 5.3 or later, and have OpenGL 1.0 and GLUT 3.6 installed. These applications can be downloaded from *http://www.opengl.org*. The vpv executable file can be downloaded to any directory in the path.

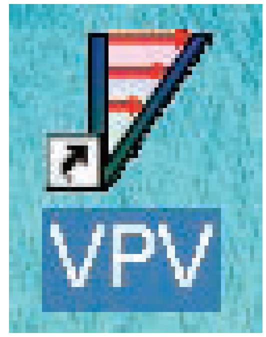

Figure A1. The Velocity Profile Viewer icon as it appears on the Windows desktop.

Running the Application

To test the installation, run the application by typing “vpv” (lowercase) or double-clicking on the application in a folder window. A window should appear with the VPV logo and an error stating that the data file was unspecified (*fig. A2*), which indicates that all required application files were found. Close the window and restart VPV with a data file argument as described in the Viewing Data section of this appendix.

If an error appears onscreen that says a DLL could not be found or if the VPV window does not appear, search the system for the required DLL files. Windows should be in at least 16-bit color mode for VPV to display correctly. Note that the actual colors that appear onscreen may vary depending on the settings for the monitor, display driver, or operating system color mode.

Viewing Data

To open a data file, type “vpv (filename)” in a command window, or drag the input file and drop it on the executable file. A sample data file, called sample.vel, is available on the VPV web site.

To open data that are stored from top to bottom, as is common for downward-looking profiles, use the "-downward" option on the command line, which simply shows the bins in reverse order. This option can be shortened to "-down" or "-d".

If an error occurs when the application is initialized or loading data, processing aborts and an error message is displayed in the window (*fig. A2*) until the application is closed. *Table A1* lists all the possible error messages displayed by VPV and their respective causes.

The interior dimensions of the VPV window are 600 x 600 pixels when it first appears onscreen. The window also shows the VPV logo and identifies the author, organization, and the revision of the application. VPV reads the header of the data file to determine the number of time steps in the file and then allocates the appropriate amount of memory to store the data. As each data time step is read, a progress meter in the window displays the amount of allocated space that has been filled (*fig. A3*). For small data sets, the progress meter may be displayed only for an instant.

If either velocity component of a bin at a particular time step is less than -999 or greater than 999, the data for that bin are interpreted as missing and both components are stored as zeros. VPV works with filtered and unfiltered data and data files with or without water-level data. See *appendix 2* of this report for more information regarding data input.

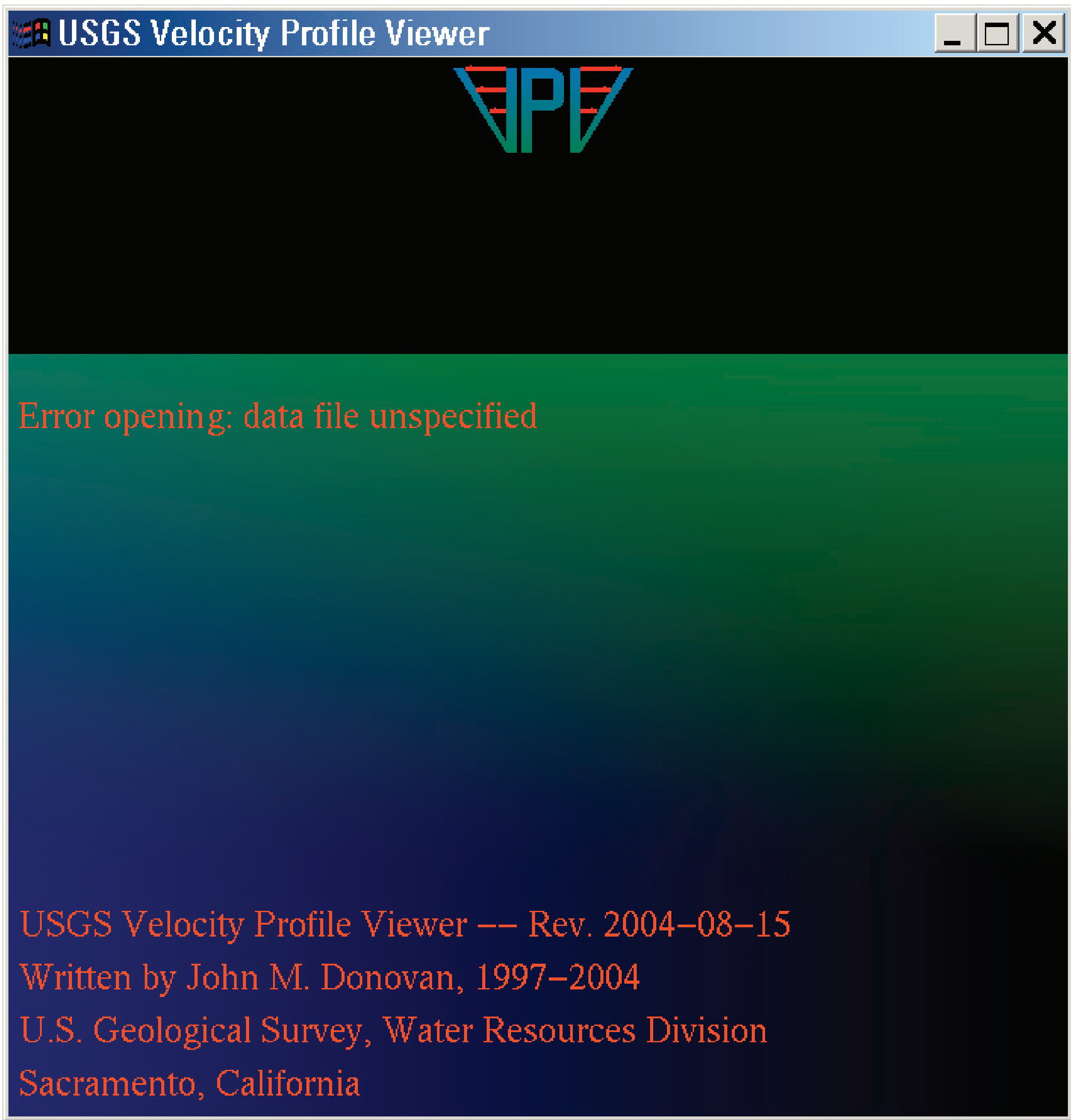

Figure A2. The Velocity Profile Viewer window displaying an error message that the data file was unspecified.

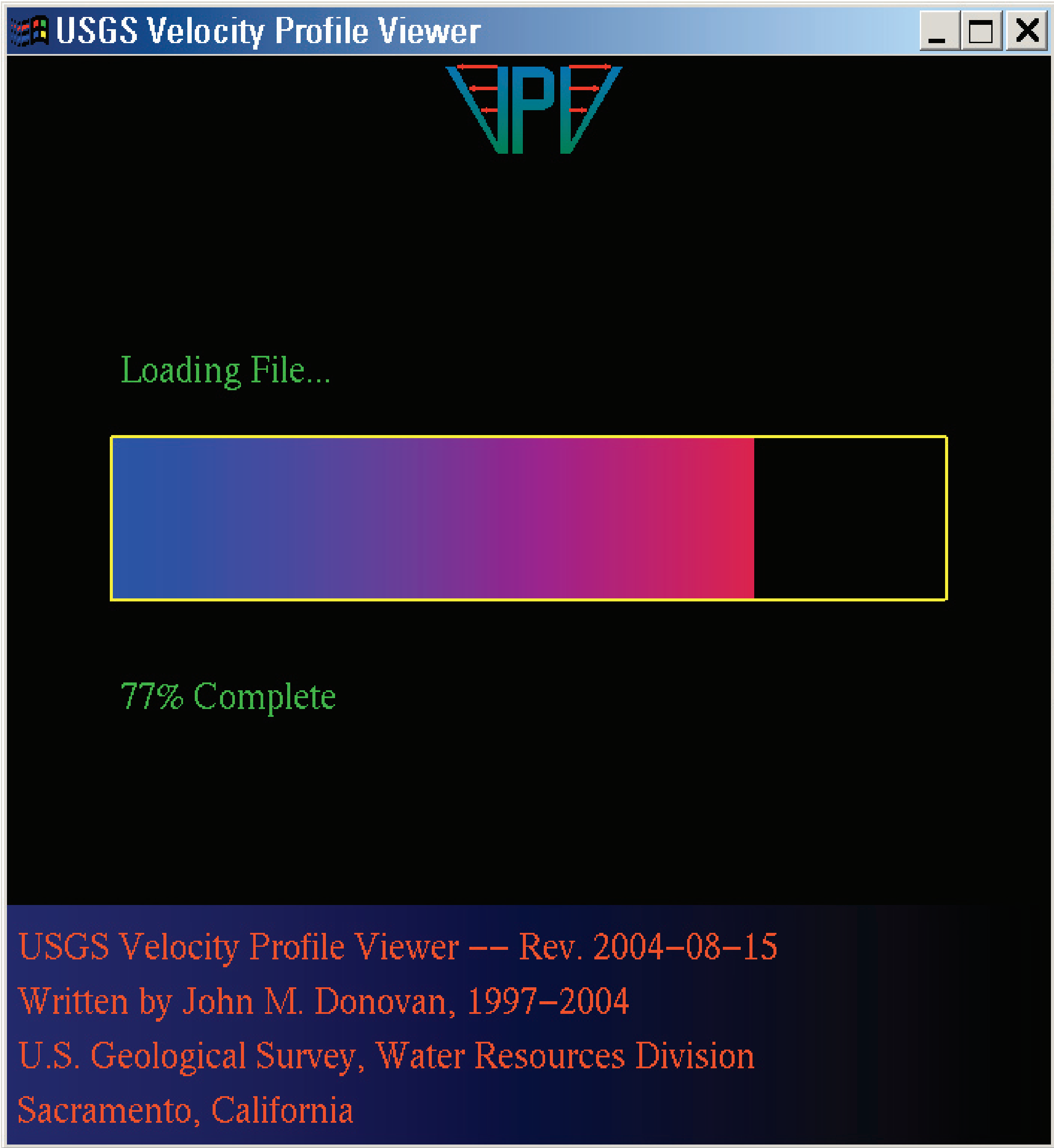

Figure A3. The Velocity Profile Viewer window displaying a progress meter onscreen while loading a data file.

Table A1. Error messages and their causes displayed by the Velocity Profile Viewer.

Error Message	Cause of Error
Error reading location at line 1	The end of the file was reached before the end of the first line.
Error reading header at line 3	The end of the file was reached before the end of the third line.
Error reading header at line 4	The end of the file was reached before the end of the fourth line.
Error reading header: bad start date	A valid start date could not be computed, probably because the year, month, or day of the start date were out of range, not in the proper columns, or missing altogether.
Error reading header: bad end date	A valid end date could not be computed, probably because the year, month, or day of the end date were out of range, not in the proper columns, or missing altogether.
Error in header: check start and end dates	The span from start date to end date was less than zero or greater than 5,000 days.
Error in header: check bin info	(1) The number of bins, computed as the difference between the first and last bin in the header, is less than zero, greater than 1,000, or missing altogether. (2) The time step increment is less than or equal to zero or greater than 100.
Error opening: data file unspecified	No data file was specified as an argument, either on the command line or by dragging it onto the application (shown in *fig. A2*).
Error opening: data file filename	The file named “filename” could not be found and opened.
Error: no time series data were read	No data were recognized in the file after the header.
Error: data file could not be read	There was an error reading the data file that was not caught and handled by one of the other error messages.

Appendix 2: Data Format Description

The main file format used by VPV consists of a five-line header followed by multiple records describing the velocity profile at each time step. The following is a short file listing of the VPV data format, with only the first two time steps showing:

```
SAMPLE                                                       .......Line 1 (File Header)
15219951621995                                               .......Line 2 (File Header)
38 3 1122 6 2                                                .......Line 3 (File Header)
    1        23         0.16667    0.50000                   .......Line 4 (File Header)
   95    6    1          95     6    10                      .......Line 5 (File Header)
   0.00000  14.83000   95     6     1 1150                   .......Line 6 (Time Step Header)
     1    -38.50    -14.50                                   .......Line 7 (Bin 1, Time Step 1)
     2    -37.50     -9.70
     3    -31.60     -3.80
     4    -37.00    -10.10
     5    -37.90    -14.10
     6    -38.80    -18.60
     7    -42.60    -18.30
     8    -42.60    -19.80
     9    -41.00    -21.30
    10    -41.70    -23.40
    11    -42.50    -24.00
    12    -41.40    -27.70
    13    -39.90    -26.60
    14    -40.60    -27.90
    15    -41.60    -25.10
    16    -39.00    -25.20
    17    -39.40    -21.20
    18    -36.60    -15.90
    19    -16.45    -10.05
    20   9999.99   9999.99
    21   9999.99   9999.99
    22   9999.99   9999.99
    23   9999.99   9999.99
   0.16667  14.83000   95      6      1 1167
     1    -25.00     -8.90
     2    -25.50     -9.20
     3    -25.80    -10.10
     4    -29.90    -12.70
     5    -29.80    -13.70
     6    -29.70    -13.60
     7    -30.90    -12.50
     8    -33.00    -12.00
     9    -34.60    -13.90
    10    -33.50    -14.40
    11    -33.70    -14.50
    12    -32.90    -16.60
    13    -33.00    -17.30
    14    -33.10    -18.30
    15    -32.10    -18.80
    16    -33.00    -18.00
    17    -36.10    -18.40
    18    -36.80    -21.10
    19    -32.90    -20.10
    20   9999.99   9999.99
    21   9999.99   9999.99
    22   9999.99   9999.99
    23   9999.99   9999.99
```

The first five lines of the file contain header information. Only the first 40 columns of the header are read. Comments can be written to the right of column 40. The data for each time step begin at line six. For each time step, there is one header line, which includes date and time, followed by one line for each bin. Each bin must have a line, even if the data are missing.

Header Format

Table A2 describes each line in the header. The first line of the header is the name of the station where the data were collected, and must be between 0 and 40 characters long. Extra characters at the end of the line are ignored.

VPV skips the second and third lines and doesn't use the provided information. The two lines can be blank or they can be filled in as described below.

The second line is a 14-digit integer that tells the starting and ending date of the record. Digits 1–3 are the starting Julian day, digits 4–7 are the starting year, digits 8–10 are the ending Julian day, and digits 11–14 are the ending year.

The third line is the latitude and longitude of the collection station.

The fourth line is made up of four fields. The first field is an integer representing the lowermost (first) bin in the vertical velocity profile; typically 1. (The bin-numbering scheme is assumed to start at the bottom and work upward unless the "-d" option is given). The second field is an integer representing the number of the last bin, which can be as large as 30. The third field is a decimal number representing the time step increment, in hours. A 30-minute interval would be recorded as "0.5". The fourth field is a decimal number representing the bin height. This field is ignored by VPV. The Fortran format to write this line would be "I5, 1x, I9, 6x, F9.5, 1x, F9.5". VPV is written in the C programming language, however, and it reads only two int values and a float value separated by spaces.

The fifth line has six fields, all integers. They are the starting year, month, and day, and ending year, month, and day. The Fortran write format would be "3(1x, I4), 5x, 3(1x, I4)", but VPV just looks for six int values separated by spaces. VPV uses these dates to calculate the size of its storage array. The application will give an error regarding Julian start or end dates if any of these fields are missing.

Table A2. Description of each line of the header in the input file for the Velocity Profile Viewer.

[VPV, Velocity Profile Viewer]

Line Number	Location	Description
1		Profile identification
	Columns 1 - 40	Name of the station where the data were collected, alpha-numeric (40 characters).
2		Starting and ending dates. Ignored by VPV.
	Columns 1 - 3	Starting Julian day, integer, includes leading zeros.
	Columns 4 - 7	Starting year, integer.
	Columns 8 - 10	Ending Julian day, integer, includes leading zeros.
	Columns 11 - 14	Ending year, integer.
3		Profile geographic location. Ignored by VPV.
	Columns 1 - 2	Latitude degrees, integer.
	Columns 3 - 4	Latitude minutes, integer.
	Columns 5 - 6	Latitude seconds, integer.
	Columns 7 - 9	Longitude degrees, integer.
	Columns 10 - 11	Longitude minutes, integer.
	Columns 12 - 13	Longitude seconds, integer.
4		Bin information.
	Field 1, Space Delimited	Number of first bin, integer.
	Field 2, Space Delimited	Number of the last bin, integer.
	Field 3, Space Delimited	Time step increment in hours, decimal number.
	Field 4, Space Delimited	Bin height, decimal number. Ignored by VPV.
5		Starting and ending dates.
	Field 1, Space Delimited	Starting year, integer.
	Field 2, Space Delimited	Starting month, integer.
	Field 3, Space Delimited	Starting day, integer.
	Field 4, Space Delimited	Ending year, integer.
	Field 5, Space Delimited	Ending month, integer.
	Field 6, Space Delimited	Ending day, integer.

Time-Step Data Format

The rest of the data file consists of a record for each time step. Each record has a single-line header, followed by a line for each vertical bin. *Table A3* describes the header and data lines for a time-step record.

The time-step header line has six fields. The first two fields are decimal numbers and the last four fields are integers. The first field is the time, in hours, since the beginning of the file. The second field is the water level. If water-level data are not available, the value of the field should be zero. The last four fields are the year, month, day, and time of the record. The time is shown as a decimal representation of the hour, multiplied by 100. For example, 11:30 p.m. would be “2350”. The Fortran write format for the line would be “F10.5, 1x, F9.5, 4(1x, I4)”. VPV uses a pivot year of 60 for all two-digit years. Therefore, dates are assumed to be between the years 1960 and 2059 unless they are entered with four-digit years.

The lines for each record have three fields each. The first field is the bin number, starting at 1. The second field is the U component of the velocity, usually east. The third field is the V component of velocity, usually north. The Fortran write format of the line would be I6, 2(1x, F9.2). If the data for a bin are missing at a given time step, the U and V values should be 9999.99. An example of missing data is shown for bins 20–23 in the file listing at the beginning of *appendix 2*.

Table A3. Description of the header and data line of a timestep record in the input file for the Velocity Profile Viewer.

Line	Field Number, Spaced Delimited	Description
1		Time and water level.
	1	Time in hours since the beginning of the file, decimal number.
	2	Water level, integer.
	3	Year, integer.
	4	Month, integer.
	5	Day, integer.
	6	Time as decimal hour multiplied by 100, integer.
2 through (number of bins + 1)		Bin number and velocity
	1	Bin number (1 to number of bin), integer.
	2	U velocity component, decimal number.
	3	V velocity component, decimal number.

Appendix 3: Legal Notice

VPV is free software. Permission is hereby granted to redistribute and use the software as long as the USGS is given credit for being the original creator and this notice accompanies the software. Use, modification, and redistribution of the source code is allowed under the terms of the GNU Lesser General Public License (Free Software Foundation, Inc., accessed July 15, 2004), wherever it applies to U.S. Government software.

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